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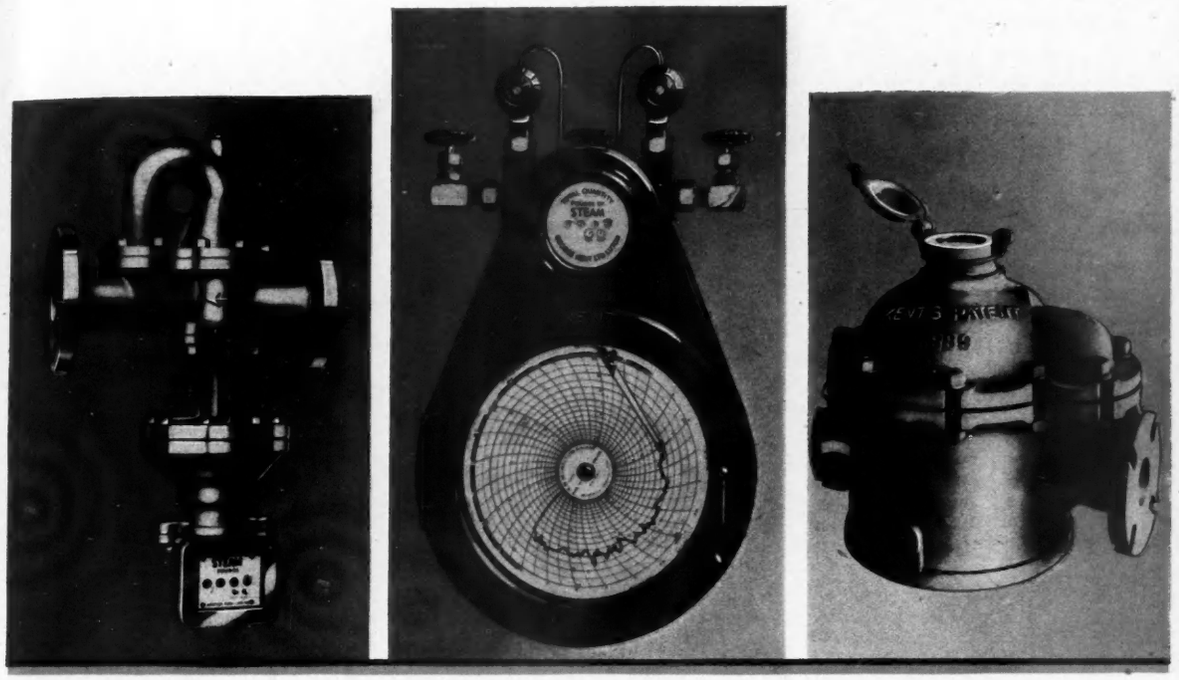

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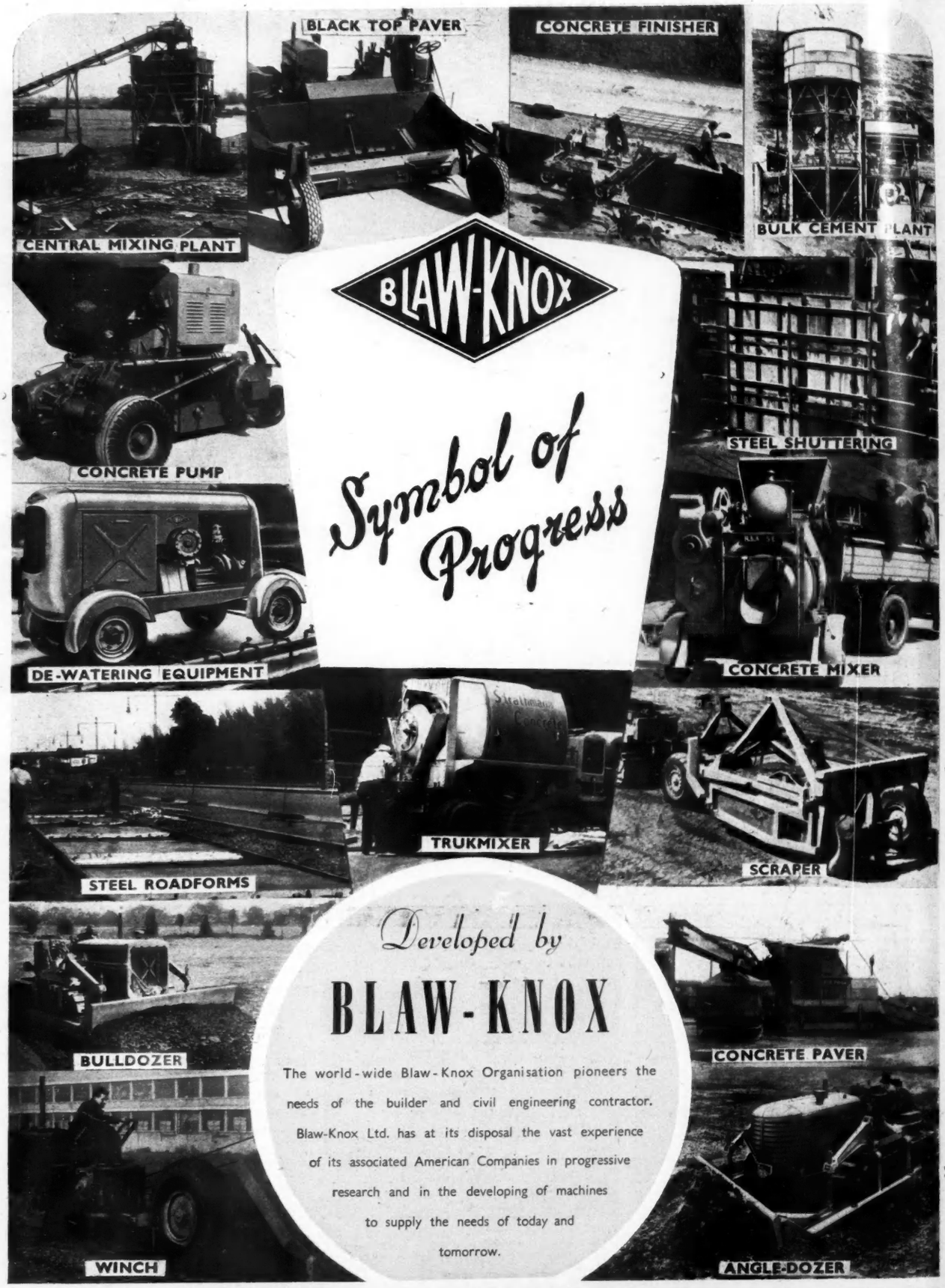
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The Engineer

LONDON, FRIDAY, OCTOBER 1, 1943.

PUBLIC NOTICES

INSTITUTION OF CHEMICAL ENGINEERS

EXAMINATION, 1944

Application Forms Returnable 1st December, 1943, and particulars of the ASSOCIATE MEMBERSHIP EXAMINATION for 1944 may be obtained from the HON. REGISTRAR, INSTITUTION OF CHEMICAL ENGINEERS, 56, VICTORIA STREET, WESTMINSTER, LONDON, S.W.1. 8371

WEXFORD COUNTY COUNCIL

COMPETITION FOR DESIGN OF BRIDGE

NOTICE TO CIVIL ENGINEERS

The Wexford County Council invite Civil Engineers to take part in a COMPETITION for the DESIGN of a BRIDGE over the estuary of the River Slaney at Wexford. The clear width of the roadway is approximately 1020ft. The bridge is to be in reinforced concrete.

Two independent assessors have been appointed, and their final award will be accepted by the Council.

Conditions of the Competition, including the names of the Assessors and amounts of premiums, instructions to competitors, details of procedure, schedule and form of entry, may be obtained from the undersigned.

N. J. FRIZELLE,
County Secretary.

County Hall,
Wexford,
September, 1943. 8375

SITUATIONS OPEN

TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors regard to insert brief notices that vacancies filled, upon receipt of notifications from the advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

STATUTORY RULES & ORDERS
1941 No. 2069
RESTRICTION ON ENGAGEMENT ORDER

ENGINEER AGENT REQUIRED for a contract abroad; must have extensive experience of Tidal Work and the Sinking of Caissons, Monoliths, and Mains under Water.—Address, 8381, The Engineer Office. 8381 A

OVERSEAS EMPLOYMENT.—Men Employed in Ship Repair Yards are INVITED to APPLY for the undermentioned VACANCIES in the Newfoundland Dockyard. Men will not be asked to take their families with them, and the contract will be for the duration of the war. Free transport will be provided to and from Newfoundland, and accommodation and meals will be available at an inclusive charge of 3 dollars a day. The rate of wages for all trades is 87 cents per hour on a guaranteed 48-hour week; all overtime worked is paid for at the rate of 1 dollar per hour (1.00 dollar equals 4s. 5d. at present rate of exchange).

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ONE MACHINIST MARKER-OFF (Surface Table Man).
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Written applications (no interviews), giving particulars of age, National and Armed Forces Registration Numbers, apprenticeship, references, and name of present employers, should be sent to the SECRETARY, Overseas Labour Committee (Ref. 874), Ministry of Labour and National Service, Alexandra House, Kingsway, London, W.C.2. 8368 A

MANAGER REQUIRED for Modern High-speed Diesel Engine Factory, engaged in production and extensive overhaul programme. Only expert knowledgeable applications to be considered. State age and full particulars. Address, 8378, The Engineer Office. 8378 A

The Engineer

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THE FACT that goods made of raw materials in short supply owing to war conditions are advertised in this paper should not be taken as an indication that they are necessarily available for export.

SITUATIONS OPEN

DEPARTMENTAL MANAGER REQUIRED for Heat Treatment Department, Steel Works, North Midlands; must have had previous experience and technical education; capable of labour control and organising ability. Permanent position, salary £600 per annum. State age and experience.—Address, P8335, The Engineer Office. P8335 A

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MANAGER REQUIRED for Planning Department of old-established Engineering Factory employing 1500 people, responsible for programme planning, shop loading and internal and external progressing. Situation has post-war prospects.—Address, giving full particulars and salary required, 8355, The Engineer Office. 8355 A

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SITUATIONS OPEN

THE Post You Are Seeking May Not Be Advertised in this Column, but do not lose the Opportunity of Bringing your Requirements before all those who would be interested and could employ you. An Advertisement in the "Situations Wanted" Column would be seen by all Leading Engineering Concerns for the cost of Four Lines, 6s.; 1s. 6d. for each Additional Line. There is no better way of covering so large a field for such a small charge.

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SITUATIONS WANTED

ADMINISTRATIVE APPOINTMENT DESIRED (London district). Excellent commercial and engineering ability, 15 years' experience with one firm as general manager, co-ordinating all depts., including design, production control, sales, accounts, &c., in light general engineering concern employing approx. 1300; used to controlling executive staff and taking full responsibility.—Address, P8319, The Engineer Office. P8319 B

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EXPERIENCED DRAUGHTSMAN REQUIRES SPARE-TIME WORK (20 hrs.), Designing, Drawing, Colouring, and Lettering, &c.; moderate charges.—Address, P8342, The Engineer Office. P8342 B

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IF the Man You Are Seeking is Not Amongst those Advertising in this Column, a Small Announcement in the "Situations Open" Column will Quickly and Economically Produce the Right Selection of Applicants, at the same time Eliminating Waste of Effort, Waste of Time, and Waste of Opportunity. The charge is Four Lines or under, 6s.; each Additional Line, 1s. 6d. Box Numbers, 1s. extra, which includes despatch of all replies.

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Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher; all other letters are to be addressed to the Editor of THE ENGINEER.

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Continuation of Small Advts. see page

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The National Arbitration Tribunal

ON Tuesday, September 28th, a meeting of the National Arbitration Tribunal took place in order to give an interpretation of its findings in the engineering wages award which was made in March last, and was outlined in a Journal note of March 26th. For some time past complaints have been made in the engineering industry with regard to the comparatively small number of employees who are eligible for wage increases. The matter has now been brought to a head by the strike of 9000 workmen at Vickers-Armstrongs' works at Barrow-in-Furness. The strikers claim that the interpretation of the award by the employers is wrong, although no official complaint on this score has yet been made by the engineering trade unions. They claim, too, that a large number of the men who are now employed on the premium bonus system should be entitled to more money. In view of the serious position at Barrow, which is slowing down production and has already stopped work of the highest importance connected with the defence programme, despite a personal appeal made to the strike committee by Sir Charles Craven, a quick decision is being sought. The Executive Committee of the Amalgamated Engineering Union has endeavoured to maintain discipline without success. It has suspended the district committee of the union because it authorised the tendering of strike notices, which the Executive Committee cancelled shortly before they expired. This has been followed by the resignation of the secretaries and officials of the Amalgamated Engineering Union of the fifteen branches in Barrow. At Tuesday's meeting a decision on this point at issue was quickly reached by the Tribunal, but its nature up to the moment of going to press has not been publicly revealed.

A New British Explosive

DURING last week-end it was officially announced by the Ministry of Supply that a new explosive, higher in power than T.N.T., is now being used by the United Nations. It is called R.D.X. and takes its name from Research Department, Formula X. R.D.X. is now being made in Canada and the United States of America, and it is stated that the progress made in both countries has enabled the new explosive to be produced more simply and more cheaply than anywhere else. All the United Nations will feel the benefit of the British experiments, and the American and Canadian production and development. It is now revealed that the new explosive was known to scientists in the early part of the century, but they were faced with the difficulty of making R.D.X. on a useful scale. Only a few years before the outbreak of war their problem was finally solved by the War Office Research Department. We may recall that early in July, 1936, an explosion took place in Woolwich Arsenal during the filling of a 15in. shell, and five men were killed and others injured. They were Commander P. A. M. Long, an Admiralty ordnance assistant, of Sevenoaks, Kent; F. C. Lewis, a scientist, of Abbey Wood; J. Brignall, a laboratory assistant, of Welling; S. H. Cooper, a leading factory hand, of Plumstead; and W. E. Johnston, a factory hand, of Plumstead. This accident was described, following the inquest, in a Journal note of July 27th, 1936, but at the time we were not allowed to state that a new explosive was being used.

A New India-China Road

NEWS has now been given of the construction of a new road to China, which is being constructed across the eastern frontier of India. Starting from a point in Assam, it is being planned to link up with the old Burma Road at some point between Lashio and Chungking. The work, it is now revealed, was begun in December last. It is being constructed under the supervision of Major-General Stilwell, Commander-in-Chief of American Forces in India, Burma, and China. The supply and engineering sides of the work are under the charge of Brigadier-General Raymond Wheeler, while Brigadier-General Hayden Boatner, Chief of Staff to the Chinese Army in India, is responsible for the tactical protection of the new road. American engineers are directing the building of the road, which is being carried out in accordance with the American practice. Many rock crushers and lorries and jeeps are being used for the production and transport of the material needed. The workers comprise an international army of Chinese, Indians, and Americans, with some tribesmen from the Garo Hills. Some of the workmen were previously employed on the building of the Alaskan Highway. It is reported that the work is particularly arduous, as the road must pass through jungle, which is exposed to frequent torrential rains. Other factors to be reckoned with include mud and possible landslides, while the workers are liable to attack from malaria and leeches.

Some Reasons for Reduced Coal Output

IN the course of a statement made in Birmingham on Monday, September 27th, Mr. Frank Hodges, who, it will be recalled, was himself a miner and a former secretary of the Miners' Federation of Great Britain, and is now a director of several colliery companies, outlined what he considered should be done to increase the output of coal. He suggested that it would be wise to deconcentrate the larger coal combines and to split them up into workable units, so that the managements could exercise maximum control over the individual colliery concerns. This, he suggested, would restore the power of managements to handle their own staffs. Freedom should be given from the major limitations of the Essential Work Order. A financial structure should be established by which the parasitic element of the present system was removed. Although, Mr. Hodges went on, it was perhaps too early to say that the scheme for the control of the mining industry, as outlined in the White Paper of June, 1942, had been a failure, it had certainly not been a success. He thought that the setting up of great colliery combines had brought in their train a remoteness of control which had destroyed the old intimacy between individual management and the workmen. There was no doubt, he continued, that the strikes among workmen which were in practically all cases unofficial and contrary to advice given by the leaders, were to a large extent the direct cause of the decline in coal output. The men's leaders had, in the main, striven hard to eliminate this new element of anarchy which was creeping into the industry. Their patriotism, he had no doubt, was deep and sincere, but they were experiencing a consciousness of weakening authority.

The Future of British Shipping

THE annual general meeting of Furness, Withy and Co., Ltd., was held on Wednesday, September 22nd, and Lord Essendon, who presided, was warmly congratulated on having attained his diamond jubilee with the business of Christopher Furness and Furness, Withy and Co., Ltd. In his address Lord Essendon referred to the question of nationalisation of the shipping industry. He pointed out that, after the last war, several nations attempted to nationalise their shipping, but they all had to liquidate their positions as a result of the heavy losses that were incurred. There was no reason to believe that the position would be any different if it became a British policy. Heavy losses would certainly be incurred, and the National Exchequer would not only suffer from them, but would also lose the contributions made to the public funds in the form of taxation, and the balancing of the Budget would thereby be seriously jeopardised. Lord Essendon spoke also of the problem of shipping replacement. The money that had been received for lost ships under the war risk arrangement with the Government would not be sufficient to replace them, although admittedly it would go a good way towards so doing. A greater problem would arise in regard to the replacement of ships which had not been lost but which would require to be replaced in the not distant future. He regretted that in its hire arrangements, the shipping industry had not been allowed some additional remuneration to be used for this purpose, but he thought that the industry could safely rely on the specific assurances which it had received from the Government on the matter.

Industry and the Black-Out

IN the House of Commons on Thursday, September 23rd, the Minister of Home Security, Mr. Herbert Morrison, replying to questions on new arrangements for the black-out, said that the Government had twice carefully investigated a higher standard of street lighting which could be extinguished on alerts by a central control, but such a scheme was considered impracticable. Some modifications affecting bicycle and motor vehicle lamps, and lighting in trains, public service vehicles, and on certain railway stations, had been introduced. Vital war industry and essential services must still have first claim on any increases of light which were considered permissible, and the Government had made an investigation as to how modifications might be made in the lighting restrictions affecting industrial establishments. Whilst it was not at present deemed practicable to introduce any general measures such as the shortening of the black-out period or the abolition of the black-out in factories and other industrial establishments, certain steps had been approved which, together, would help production. It had been decided, in particular, to substitute removal for permanent black-out in a number of factories as quickly as materials and man power permitted. Details of other measures could not be made public, but the Government's policy was to consider the lighting required with representatives of the vital industries concerned, and to authorise for those industries as much light as would maintain a proper balance between the need for the light and the risk involved.

The Dismantling of Waterloo Temporary Bridge

GOOD progress, we understand, is being made with the dismantling of Waterloo temporary bridge, which is being removed in order to provide more steel for the national war effort. The bridge, we may recall, was built in 1925 by Sir William Arrol and Co., Ltd., of Glasgow, and a full description of its design and the launching of the navigation span will be found in our issue of June 26th, 1925. The method of dismantling the bridge which has been adopted is that of cantilevering back the spans and removing the ends of the cantilevered portions. Weights up to 10 tons can be dealt with by three electric travelling cranes. The work of dismantling the bridge was begun on April 21st, and the first operation was to cut off the asphalted surface of the roadway and to remove the footways and kerbs. All the Post Office cables and also some hydraulic mains had previously been removed from the bridge. A recent operation was the jacking up of the northern span and the removal of the support, in order to make that section of the bridge into a cantilever ready for dismantling. Special interest attaches to the third span from the northern side, the navigation or long span, which has a length between centres of bearings of 277ft. 4in. At the present time work is proceeding with the building of two supporting stagings in the river to support this span and to enable it to be cut through at the middle, thereby making two cantilevered portions, the ends of which will be removed in the same way as those of the other spans. The work of removing the bridge is being carried out under the supervision of Messrs. Rendel, Palmer and Tritton, of Westminster, in association with Sir Peirson Frank, M. Inst. C.E., F.S.I., Chief Engineer to the London County Council, the responsible authority, the contractors for the dismantling work being Peter Lind and Co., Ltd.

Historic Accidents and Disasters

No. XXI—*(Continued from page 241, September 24th)*

The Launch of the "Daphne"—No. II

THE art of shipbuilding was many centuries old before the factors affecting the stability of ships were recognised and studied. As late even as 1860 it was not considered necessary to investigate the stability of a ship at any considerable angle of heel. Not until after the loss of the "Captain" in 1870 did shipbuilders generally appreciate the importance, and understand the construction, of a stability curve showing the righting moment of a ship at progressively increasing angles of heel. Even then they were content with a stability curve for the ship in the finished and loaded condition. They argued that if the ship were satisfactorily stable in that condition she would be at least equally satisfactorily stable in the unloaded light-draught condition. Evidence began to accumulate that this argument was wrong. The safety of the "City of Rome" was questioned, and it was asserted that she was unsafe with less than 1000 tons of coal or cargo on board. In November, 1882, the new Orient liner "Austral," having discharged her cargo and water ballast heeled and foundered in Sydney Harbour. These and other similar incidents caused disquiet, but still no one seems to have thought it necessary to calculate the stability curve of any ship in the light-draught finished condition.

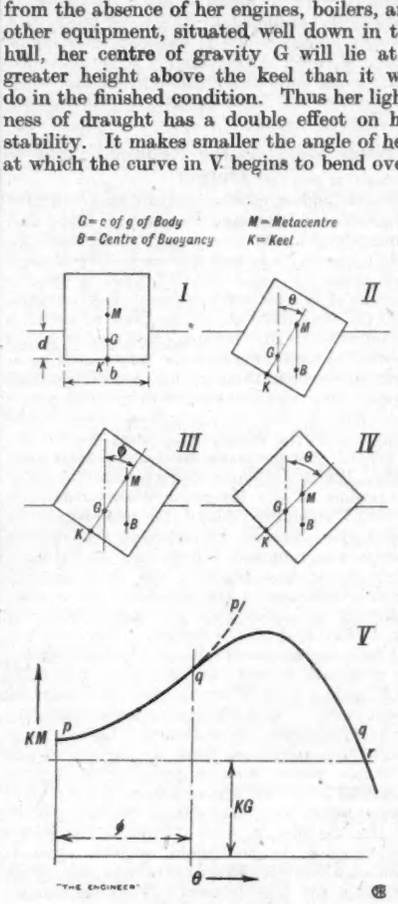
Still less was it considered necessary to calculate the stability curve of a ship in the light-draught unfinished condition in which she was launched. To determine whether a given ship could be launched safely a traditional rule-of-thumb procedure was followed. If she had any degree at all of initial stability—that is to say, if when upright at her launching draught she had a positive metacentric height of any amount, even only a few inches—and if her sides were high and unbroken, then, it was universally believed, she was safe to launch.

To expose the dangerous falsity of this belief, Sir Edward Reed discussed at great length and with the aid of many diagrams the stability of a rectangular parallelopiped floating at various draughts and with its centre of gravity at various heights. We can condense his argument into a few lines with the aid of the accompanying diagram.

If the body I heels into condition II the height of the metacentre above the keel will increase with the angle θ in accordance with the curve $p\,p$ in V. Hence if G M is initially positive, the heeling of the body will call into play a righting moment which increases with the heel. The traditional rule-of-thumb, however, omitted to take account of the change which occurs when the heel reaches an angle ϕ, such as to bring one of the lower edges level with the water surface, as shown at III. With one edge emersed, as at IV, the formula for the height K M is totally different from the formula applicable to the condition II. It is represented by the curve $q\,q$ in V. This curve joins smoothly on to the earlier curve $p\,p$ at $\theta=\phi$, but it soon reaches a maximum and then trends downwards. Sooner or later the height K M will fall to equality with the height K G, as at the point r. At this angle of heel with the metacentre coincident with the centre of gravity the body will be in imminent danger of capsizing.

The value of the angle ϕ at which the curve begins to bend over is obviously a critical factor. It is given by $\tan\phi=2\,d/b$, and is therefore less for a body floating at light draught than for the same body floating at a deeper draught. Thus for $d=\frac{1}{2}\,b$, $\phi=45$ deg., but for $d={}^3/_{25}\,b$—a figure among those studied by Sir Edward—the curve begins to bend over when ϕ is no greater than 13 deg. or 14 deg.*

Applying this argument to a ship in the light-draught condition, we have to note an additional fact. If her light draught arises from the absence of her engines, boilers, and other equipment, situated well down in the hull, her centre of gravity G will lie at a greater height above the keel than it will do in the finished condition. Thus her lightness of draught has a double effect on her stability. It makes smaller the angle of heel at which the curve in V begins to bend over,



THE STABILITY OF A PARALLELOPIPED

and also reduces the range through which the metacentre can fall before reaching coincidence with the centre of gravity.

Sir Edward Reed undoubtedly did good service in exposing the inadequacy of the traditional launching rule, and in establishing the wholly unsuspected degree of instability which a ship in the light-draught as-launched condition might possess. But as an explanation of the particular mishap into which he was inquiring, the theory, sound as it is, is unsatisfying. The question which at once presents itself is, Was the "Daphne" at the time of her launch in the light-draught condition or at least in a condition of draught sufficiently different from her designed finished draught to bring her within the ambit of Sir Edward's theory?

Evidence as to the draught of the ship as launched is conflicting. The builders appear, before the launch, to have estimated her launching weight at about 382 tons, and her mean draught at 6ft. 9in. These figures are certainly too low. Mr. Elgar, taking account of all the material, men, and tools known to be on board the ship as she went down the ways, estimated her launching displacement at 401 tons, her draught forward at 5ft. 1½in., and her draught aft at 8ft. 10½in. —or a mean draught of 7ft. Subsequently, in the light of further information, he amended his estimate of the mean draught to 7ft. 5in., which would correspond with a launching displacement of 435 tons. Even these figures may still be too low. A modern estimate by the builders makes the probable launching weight about 500 tons, implying a mean draught of about 8ft. 2in. Finally, in his report Sir Edward stated that calculations of the ship's stability at the launching draught—carried out after the disaster—showed that at a heel of 10 deg. her "lever of stability" was only about ¾in., giving a righting moment of about 32½ foot-tons. At 40 deg. inclination, he said, the lever was 7½in. and the righting moment 315 foot-tons. Each of these two sets of figures implies that the ship's launching displacement was about 520 tons, corresponding to a mean launching draught of 8ft. 4in.

From these various particulars we may conclude with fair certainty that the ratio of the ship's mean launching draught to her extreme beam was in the neighbourhood of 9/30.

What were the designed unladen draught and displacement of the ship in the finished condition? Sir Edward must or should have had these figures before him; but he failed to include them in his report. The most it tells us is that the displacement in the fully laden state would never have reached 1000 tons. Allowing at a guess 400 tons for the cargo and ballast, we may therefore suppose that her designed light-weight displacement in the finished condition was about 600 tons, which would correspond with a draught of about 9ft. 3in. Messrs. Stephen's records, we gather, confirm these figures. The designed displacement in the light-weight finished condition was, they tell us, 626 tons, corresponding to a draught of 9ft. 5½in. in sea water. We may therefore conclude that in the finished condition the ship without cargo or ballast would have had a ratio of mean draught to extreme beam of 11/30.

It is fair to infer from these various figures that at the time of her launch the "Daphne" was far from being in the condition of very light draught visualised by Sir Edward in his theoretical studies. That inference is powerfully reinforced by the fact that she was complete, except for her main boilers, uptake, funnel, and masts, and that work on her would have been finished ten days after her launch. Current opinion accepted Sir Edward's view that the ship capsized because of her instability in the light-draught launching condition. That view has persisted down the years, but it is difficult to justify it. If excessive instability were the cause of the mishap it was not primarily the instability to be associated, in accordance with Sir Edward's theory, with the temporary light-draught condition of a ship at her launching. Its cause must mainly be sought in permanent features of her design and construction, which would have given her unsatisfactory stability characteristics in the finished condition.

Sir Edward's theory is sound, but that the disaster to the "Daphne" is a good illustration of it we cannot believe. It would, we imagine, never have been accepted as such if

* For θ less than φ

$$KM=1/2\,.\,d+1/12\,.\,b^2/d\,.\,(1+1/2\,.\tan^2\theta)$$

For θ greater than φ

$$KM=1/2\,.\,b/\tan\theta-1/3\,.\,\sqrt{2\,b\,d}\,.\,(1-\tan^2\theta)/\tan^{3/2}\theta$$

The two formulæ give the same value of K M for $\theta=\varphi$ and at that point their tangents have the same angle of slope.

Sir Edward had been a little more frank and precise in setting forth the particulars of the ship's launching condition, and how they compared with the corresponding particulars for the finished condition. The case of the "Hammonia" appears to be a far better illustration of the application of Sir Edward's theory. That ship was very probably in a truly light-draught condition when launched, although we cannot be fully certain—again because of a curious omission on Sir Edward's part. After the mishap to her, particulars of which have already been given, Mr. J. H. Biles, then naval architect to Messrs. Thomson, calculated her stability curve. It was the first curve for a ship in the launching condition ever to be drawn. In submitting a tracing of it to Sir Edward Reed during his inquiry into the "Daphne" mishap, Mr. Biles said that the curve had been calculated for the condition in which the "Hammonia" was actually launched, and that the particulars necessary for identifying that condition were marked upon the tracing. Sir Edward in his report reproduced Mr. Biles' curve, but left out the particulars. Nevertheless, we have no evidence that, as launched, the ship was in other than a light-draught state, and therefore are prepared to accept the implication that her draught was such as to bring her within the scope of Sir Edward's theory.

Mr. Biles' calculations showed that the "Hammonia" had an initial metacentric height of about 7¼in., a figure which, according to the traditional theory and also according to past experience with ships of similar initial metacentric height, should have made her safe to launch. The full stability curve, however, showed that the righting moment reached a maximum value at a heel of about 33 deg., and became zero at 50 deg., thereafter being negative. This result came as a great surprise to Messrs. Thomson, Mr. Biles, and all who learnt of it. On the assumption that the ship as launched was in a condition of very light draught, it is, however, fully in accordance with Sir Edward's theory and was so accepted to be by all concerned, following the "Daphne" inquiry.

If the "Daphne" capsized at launching because of her instability and if that instability was not due to her very light draught, to what is it to be ascribed? The evidence of several witnesses examined by Sir Edward Reed seems to supply a reasonable answer to that question. She lacked stability sufficient to make her launching safe, not because in the temporary launching condition her draught was very light, but because permanent features of her design and construction were too heavy.

In placing the order for the ship, the owners laid down the required dimensions and displacement, and closely specified all the equipment and fittings for her. In these respects they placed themselves entirely in the hands of their superintending engineer, a man who had so little knowledge of naval architectural science that he did not know that the placing of heavy equipment high up on the top deck would in any way affect the ship's stability. He was assisted by a resident overseer—a ship's carpenter by trade—who had no power and little inclination to criticise his superior's plans and proposals.

Responsibility for the stability of the finished ship in the working condition was placed upon Messrs. Stephen, and as soon as the ship's lines had been fixed they constructed her stability curve and satisfied themselves that when finished and loaded the ship would possess satisfactory stability. Nevertheless, they were bound down by the specification. Certain parts had to be "to the owner's approval"—in effect to their superintending engineer's approval. Many of the fittings and much of the deck equipment—including the winches, steam windlass, steering gear, rudder, bollards, and boat davits—were specified by the use of the words "same as ss. 'Briar'" or "see ss.' Briar'"—the "Briar" being a much larger vessel built for the same owners in 1882. In this way equipment and fittings of excessive weight for the size of the ship were accumulated on her upper deck and in, addition, the deck houses, already heavy, were made heavier still by being covered with lead.

During the building of the ship remarks were made by those employed on her construction concerning the weight of the material and equipment being built into her, particularly on the upper deck. But these remarks failed in general to make the least impression on the superintending engineer, or never got beyond the ears of his assistant. No suspicion crossed their minds that these heavy deck weights would seriously affect the ship's stability. In any event, so they appear to have argued, the stability of the ship was a subject coming entirely within the builders' sphere of responsibility. They failed to realise that once the ship's lines had been settled the builders had very little, if any, control over her stability characteristics.

Thus it came about that the "Daphne" was launched with a weight heavier than had been expected and allowed for and the excess weight was mainly concentrated high up on the top deck in the worst possible position from the point of view of her stability. All the evidence refutes the legendary view that she capsized because at the time of her launching she was in a dangerously light-draught condition. There is scarcely any room for doubting that her mean draught at launching was closely comparable with her intended finished draught in the unladen condition. She capsized, so we are forced to conclude, because the weight and distribution of her structural parts and equipment endowed her permanently with poor stability, a stability too poor to enable her in the unladen, unballasted condition to recover from the heel imparted to her at her launch by the river currents, the unequal action of the drags, the centrifugal effect of the curved course which she followed on leaving the ways, or other cause.

After the disaster, the "Daphne" was refloated and docked, and on July 28th Sir Edward Reed carried out inclining experiments on her for the purpose of determining the position of her centre of gravity. Ultimately, after making many adjustments and assumptions, he estimated that as launched she had a metacentric height of 4in. He also calculated her stability curve at her launching draught—he did not state what figure he assumed for it—and found that the righting moment increased slowly to a low maximum at a heel of about 36 deg., and then fell rapidly to zero at a heel of about 52 deg. While these calculations, for what they are worth, confirm the obvious fact that the ship's stability was poor, they are of little value for analytical purposes, because of the many considerable assumptions on which they were based and because of the omission from the report of vital data necessary for their full interpretation.

After reconditioning, the "Daphne"—renamed the "Rose"—went into commercial service, presumably permanently loaded with a considerable amount of ballast. It is said that misfortune dogged her throughout the whole of her career. Before the end of the year 1883 she sank in Portrush Harbour as a result of settling down, with the outgoing tide, on her own anchor. Repaired, sold to other owners and renamed "Ianthe," she stranded in the Clyde in March, 1884, through mistaking the Cumbrae Light for the Cloch. In 1889 she was sold to Greek owners, who renamed her "Eleni," and used her on the inter-island trade. Of her final fate we have no certain record. One report has it that she finished her days in a shipbreaker's yard some years after the close of the war in 1918. Another report, however, states that she ended her career by being wrecked either in the Mediterranean or the Red Sea.

Engineers and the British Empire

By Professor MIDDLETON SMITH, M.Sc., M.I. Mech. E., LL.D.

No. XIII—(*Continued from page 242, September 24th*)

Timber and Wood Pulp

THE forests of Australia are composed of hardwoods and other trees. The eucalyptus yields a great deal of sawn timber. The trees are very high, up to 250ft., although in the savanna woodlands of the dry interior these trees, some 40ft. to 60ft. in height, flourish on an annual rainfall of 8in. to 10in. The timber export trade is confined to two types of eucalyptus, the Jarrah and the Karri. The physical properties of Jarrah commend it for all constructional work for civil engineering and building purposes. Its density (at 12 per cent. moisture) is 55 lb. per cubic foot. The modulus of rupture is 15,000 lb. per square inch. It has exceptional fire-resisting properties and in beam and column work it has been demonstrated that Jarrah is far superior to unprotected steel, on account of its ability to continue its work under conditions where steel would long before have buckled as a result of the intensity of the heat. It is of interest to note that Jarrah timber was used successfully on the Liverpool-Southport 600-volt section of the Lancashire and Yorkshire Railway. Tests proved that it will not burn with a flame and it smothers an arc when formed.

Karri ranks amongst the tallest of the eucalypts, and trees up to 270ft. in height have been measured. It grows where the average rainfall is from 40in. to 50in. The properties are very much the same as Jarrah, the modulus of rupture being higher, at 17,300 lb. per square inch. It has been found satisfactory for the manufacture of wooden pipes and has been used for water power systems, although the water pressure is considerably greater than that usually advisable for wood stave piping. The Commonwealth Council for Scientific and Industrial Research has proved that Karri, both young and mature, is a suitable raw material for the manufacture of paper pulp.

Tasmania fortunately possesses large timber resources and cheap water power, which enables mills there to manufacture wood pulp and newsprint. Many years of experiment have proved that the eucalyptus can be prepared so that it becomes suitable for

the production of newsprint. Mills have also been erected in the northern part of the island, where fine art paper is being manufactured.

Electricity Supply in Australia

The electric power resources were sufficiently developed to accommodate the normal growth in demand in 1939, but the immense development of the war industries and the inevitable delay in the delivery from Britain of plant ordered for extensions have caused anxiety amongst those responsible for supply.

In 1938 the central generating stations had a combined effective output of 1,274,000 kW; some 385 light and power stations produced at that date some 4353 million units per annum. Since then there have been considerable extensions of plant, and in some stations overloading above normal practice had to be risked. The charges made for supply are comparable with those in Great Britain.

There are large power stations operating solely to supply electric railways and tramways. In spite of the available coal supply, great efforts have been made to develop hydro-electric schemes. A feature is the availability of supply in the far outlying districts so that farmers, some distance from a town, have the advantage of electric power and light.

Tractor Hauling Whim and Jarrah Log

In general, the various governments of the states maintain a strict control of electric supply and their engineers supervise much of the work, but in some states there are companies concerned with the supply and/or distribution of electricity.

A few figures showing the developments during the last twenty years in Sydney may be taken as typical of the progress made in Australia. The maximum demand has increased from 50,000 kW to 220,000 kW, and the units sold rose from 100 million to 220 million. The revenue has increased three and three-quarter times. Messrs. Preece, Cardew and Rider, Westminster, act in Britain for Sydney, Adelaide, and Melbourne. The Adelaide Electric Supply Company serves the whole of the metropolitan area and numerous country districts; in the former area the scale descends from 2½d. per unit for the first 500 units per month to 0·76d. per unit for all power in excess of 7500 units per month.

In Victoria 87·5 per cent. of the population—almost two million—have reasonable access to supply. About 10,000 route miles of transmission and distribution lines supply Melbourne and 478 country towns. The State Electricity Commission generates 97 per cent. of the electricity distributed by authorised authorities. In 1940 the effective capacity of its power stations aggregated 260,000 kW. Some details of the work done in this state will give a very good idea of the enterprise in the Commonwealth in connection with electricity supply.

The Supply in Victoria

The credit for the remarkable and bold schemes to supply current to almost everyone in Victoria must be given primarily to a famous engineer, Lieut.-General Sir John Monash, D.Eng., who, when Chairman of the State Electricity Commission, had exceptional qualifications to guide his fellow-commissioners and the technical staff.

The 1918 Electricity Commissioners Bill, based upon experience in other countries (principally the United Kingdom), together with later supplementary Acts, placed the State of Victoria amongst the leading countries of the world in the matter of electrical legislation. An Advisory Committee on Brown Coal in 1917 had caused the Government to consider (1) the rapidly increasing demand for electricity for industrial, traction, and household purposes in the metropolitan area; (2) supply to provincial districts; (3) reduction of generating costs by the use of brown coal; and (4) by opening up the vast brown coal deposits in the vicinity of Morwell so that the supply would be independent of imported fuel and immune from industrial troubles in other states.

The Morwell brown coalfield was opened up; a power-house was established thereon, with an initial capacity of 80,000 H.P., and with necessary transmission lines, &c.; suitable housing accommodation was provided at Yallourn; briquetting machinery was installed; research work with brown coal was undertaken to determine the commercial possibilities of its utilisation in connection with by-product recovery and as pulverised fuel. The railway power station, Newport A, and the new brown coal power station, Newport B, were linked together.

The Morwell power station at first was designed to house five 12,500-kW turbo-alternators with necessary steam-raising and other plant; the ultimate capacity was planned for a minimum of 150,000 kW. As an indication of the advantages to Britain of this and other Empire power schemes, it may be recorded that the equipment for the original 62,500-kW plant was supplied by various British firms; it included fabricated steel framework, water-tube boilers, and superheaters (furnaces specially designed for low-grade fuel, but providing very high furnace chamber temperatures), mechanical chain-grate stokers, double-inlet type forced draught fans, coal-handling plant, ash disposal plant, steam flow meters, indicating and recording draught meters, CO_2 recorders, steam and gas temperature meters, piping, &c. Feed pumps, steam turbines, condensers, electric shovels, and steam shovels sent from Britain were used to develop the brown coalfield. Messrs. Merz and McLellan act as consulting engineers for all three heat power stations (and for the power station at Perth, Western Australia); Messrs. Rendel, Palmer and Tritton for the Kiewa hydro-electric scheme in Victoria.

The State Electricity Commission of Victoria issued a very comprehensive report in 1937, in which it estimated that the load of 166,000 kW for 1938 would increase to 286,000 kW in 1945, and urged immediate extensions of plant. It stated that the total generating capacity, including spare plant, in 1938 would be 225,500. The system included the large heat power stations at Newport A, Newport B, Morwell, and water power stations to be described later. The Commission's advisers estimated that, although the proposed Kiewa hydro-electric scheme would incur a capital cost of £6,136,000, as against £4,981,000 for extension of the Yallourn power station, yet the relative annual expenditure would be £433,000, as against £620,000. The opinion of the Commission's Chief Engineer was confirmed by the London consulting engineers—after an extensive investigation in Victoria—who agreed that the Kiewa scheme possessed many very real advantages over competing alternatives, including that of almost complete immunity from industrial dislocations.

The Newport A (75,000 kW, mostly for electric railways) and Newport B (30,000 kW) heat-power stations are both in the metropolitan area. In 1937 the capital cost of the latter was £835,000 for effective kilowatt capacity of 19,000 (£43·9 per kilowatt), but at the completion of extensions in 1946–48 the estimates were £3,558,000 for effective kilowatt capacity of 120,000 (£29·6 per kilowatt). The estimated overall cost of generating and delivering the combined electric supply of all stations to the load centres was as follows:—In 1939, £1,530,000, or 0·472d. per unit; for 1946, £2,390,000, or 0·424d. per unit; for 1950, with Kiewa fully loaded, £2,595,000, or 0·407d. per unit. The Commission placed on record its appreciation of the valuable work done by its former chief engineer, Mr. H. R. Harper, and his successor, Mr. E. Bate, and the splendid co-operation of the civil, electrical, and mechanical engineering staffs, as well as the construction engineer's department. They said it was extremely gratifying that their proposals had been endorsed by the consulting engineers of the highest standing, from Britain, after an analysis of all factors, combined with an inspection of local terrain and a careful study of its geological, hydrological, and meteorological characteristics.

In New South Wales 110 local government bodies and seventy firms operating under franchise are engaged in supplying current. At Nymboida, in the north-eastern section of the state, a hydro-electric plant is the main source of supply for town and rural populations within an area of 6000 square miles. The Sydney County Council supplies a large part of the metropolitan area with current and a private company generates and retails electricity in a restricted area in the suburbs. The Railway Department also generates power for railway and tramway purposes and supplies in bulk to some local authorities in the metropolitan area. From the hydro-electric station at Burrinjuck

power is transmitted over about 400 miles of 66,000-volt lines. For the year 1937 the total plant installed in New South Wales was 500,000 kW and the total electricity generated was 1000 million units.

For the Government of Western Australia there were installed in the heat-power station at Perth three 4500-kW sets in 1920 and one 7500-kW set in 1923, a total of 21,000 kW.

It has not been possible to give details of the various supply plants all over the Commonwealth, but the schemes mentioned will give a general idea of the progress that has been made. It is reasonable to expect that there will be a very great increase in demand for supply as the result of the acceleration in industrial development and the inevitable and possibly rapid increase in the population of Australia.

(To be continued)

Charter Oak Bridge

THE city of Hartford, on the west bank of the Connecticut River, and the town of East Hartford, on the opposite shore of that stream, are now linked by the Charter Oak bridge. This new high-level crossing was placed in service several months ago. The Charter Oak bridge, with the use of sections of the new Hartford dyke and a thoroughfare built on top of the Park River conduit, makes it possible for motor vehicles bound in and and out of Hartford or intent upon by-passing the city to do so without conflicting in any way with local traffic on cross streets.

The bridge may be said to have had its inception in 1929, when the General Assembly —Connecticut's State Legislature—created a Bridge Commission to report on the necessity for a second bridge across the Connecticut River at Hartford. The other bridge then existing had been built in 1908. In 1931 Messrs. Robinson and Steinman, consulting engineers, New York City, prepared plans and specifications for an 800ft. suspension span over the river; and bids were received in accordance with the plans in March two years later, which indicated a construction cost of approximately 4,400,000 dollars. Just at that time, however, the country was in the throes of the depression, banks were closed, and the undertaking could not be financed.

No further action was taken until 1939, when the General Assembly authorised the Governor of the State to appoint a new Bridge Commission. That body was instructed to consider the feasibility of building a toll bridge at Hartford, and the Commission was empowered, if it found the project self-liquidating, to issue bonds of the State of Connecticut to cover the cost of constructing such a crossing. The substitution of a toll bridge for a free bridge, originally contemplated, complicated the problem because there was already available a free bridge, the Bulkeley bridge, about a mile farther upstream from the proposed site of the new structure. Assuming an interest rate of 1·75 per cent. on the capital required, and charging a low and attractive toll, traffic experts computed that the probable traffic would cover all operating expenses and amortise the required bond issue of 4,400,000 dollars within a period of about thirty years. The State Highway Department prepared a general design, with cost estimates, which indicated that the project might be carried out at a cost of about 4,200,000 dollars.

Eventually the State organisation took upon itself the work of designing the west or Hartford approach, and Messrs. Robinson and Steinman were assigned the job of designing the river crossing and the approach spans in East Hartford. These engineering consultants kept in close contact at all times with the designing staff of the State Highway Department.

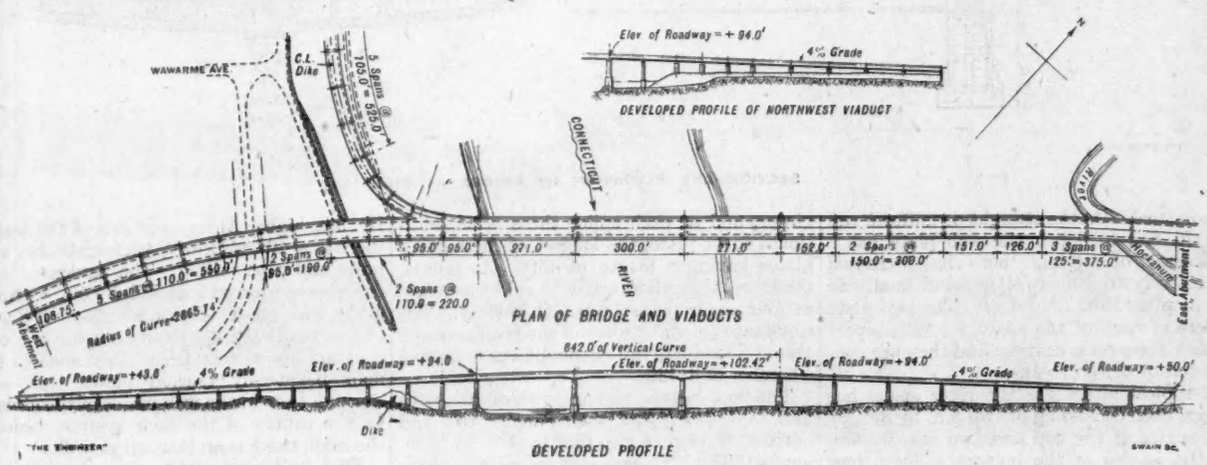
It was found that the construction of the approaches would absorb about half the proceeds of the bonds issue to cover the cost of the bridge, and the engineers were confronted with the task of devising a satisfactory river crossing that would cost about half as much as the originally planned suspension bridge. The final design took the form of a plate girder structure that could be built at an estimated cost of 1,943,490 dollars. On that design bids were tendered on September 17th, 1940, and the contract for the sub-structure was secured by A. I. Savin Company, of East Hartford, and that for the superstructure by the American Bridge Company, the combined cost totalling 1,909,467·93 dollars, or 33,022·07 dollars less than the estimated cost. Work on the substructure was started on September 30th, 1940, and work on the superstructure was begun in the autumn of 1941.

The bridge structure consists of four divisions: the river crossing, 842ft. long; the East Hartford viaduct, 1104ft. long; the south-west viaduct, which connects with a new road across the South Meadows, 1259ft. long; and the north-west viaduct that makes connection with the dyke road and has a length of 735ft. This approach leads into Hartford's business centre over the Park River Conduit Express Highway to a distributing circle at the intersection of several much-travelled thoroughfares. The bridge and its viaducts carry two roadways, each 24ft. wide between kerbs, with a central mall 4ft. wide, and at each side of the crossing there is a footpath 4ft. wide. The bridge has been designed to carry a continuous flow of traffic amounting to 5000 vehicles an hour. The maximum gradient of the approaches is 4 per cent.

The river crossing, made up of three plate girder spans, successively 270ft., 300ft., and 270ft. long between the centres of bearing on their supporting piers, are somewhat notable because of their lengths. Previous to the construction of this bridge the longest span girders were girder spans of 271ft. in length that carry automotive traffic at Cleveland, Ohio. The 300ft. central span of the Charter Oak bridge is now the longest plate girder span in the United States, and is exceeded in Europe only by a girder span 354ft. long of the Mangfall viaduct, in Germany, which has now been in service for six years.

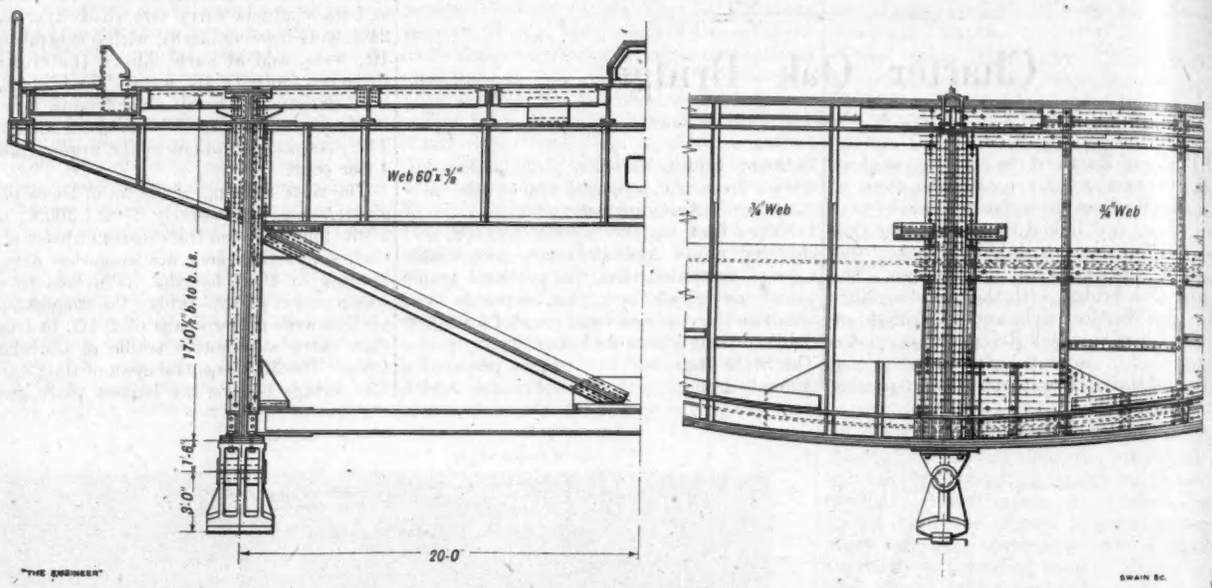
The river crossing of the Charter Oak bridge rests upon piers Nos. 12, 13, 14, and 15, piers 12 and 15 being on the river banks and piers 13 and 14 in the water. The piers have reinforced concrete frames, consisting, in each case, of two columns tied together at the top by a curved strut, and the columns rise from a solid concrete base that is partly faced with granite between low and high water for protection against erosion and abrasion. The cut granite varies in thickness from 4in. to 18in. The piers are high enough to give the mid-span a maximum under clearance of 90ft. The foundation concrete was placed in the dry within open steel sheet pile cofferdams from El. —25 below mean low water. Each foundation rests on steel piles driven down to rock, and at their upper ends the piles are embedded 5ft. in the foundation concrete. These piles are 14in. H sections of 73 lb. and their lengths range from 29ft. to 48ft. The bottom material penetrated is of fairly stiff clay topped with sand and mud. Just above the rock the river bed is of gravel, shale, clay, and hardpan. The outer line of piles around each foundation is battered.

The prevailing or " constant " depth of the



PLAN AND PROFILE OF BRIDGE

girders is 11ft. 6in. for the webs, between flanges; but at the intermediate piers—Nos. 13 and 14—the depth of the girders is gradually increased to a maximum of 17ft. directly over the centres of these two river piers. This increase in depth of web covers a longitudinal distance of 60ft. each side of a pier centre and this deepened section of web has a horizontal splice in the form of two plates, 20in. wide and $\frac{3}{8}$in. in thickness, of each of which is 23in. wide and of $\frac{5}{8}$in. material. The regular cover plate is 26in. by 1in. both top and bottom of a girder, but at points of greater stress for each of the 270ft. spans—that is, near the centre of each span there are three cover plates, top and bottom. Likewise at the intermediate piers, Nos. 13 and 14, there are also three cover plates, top and bottom. The 300ft. central span has two top and two bottom cover plates for each girder, and at each splice there is an additional cover plate, the longest of these cover plates having a length of 45ft. At points, therefore, the girders are stiffened by as many as four cover plates, top and bottom. The top flanges of the girders of the river crossing are on a symmetrical parabolic curve having a camber of 8·42ft.

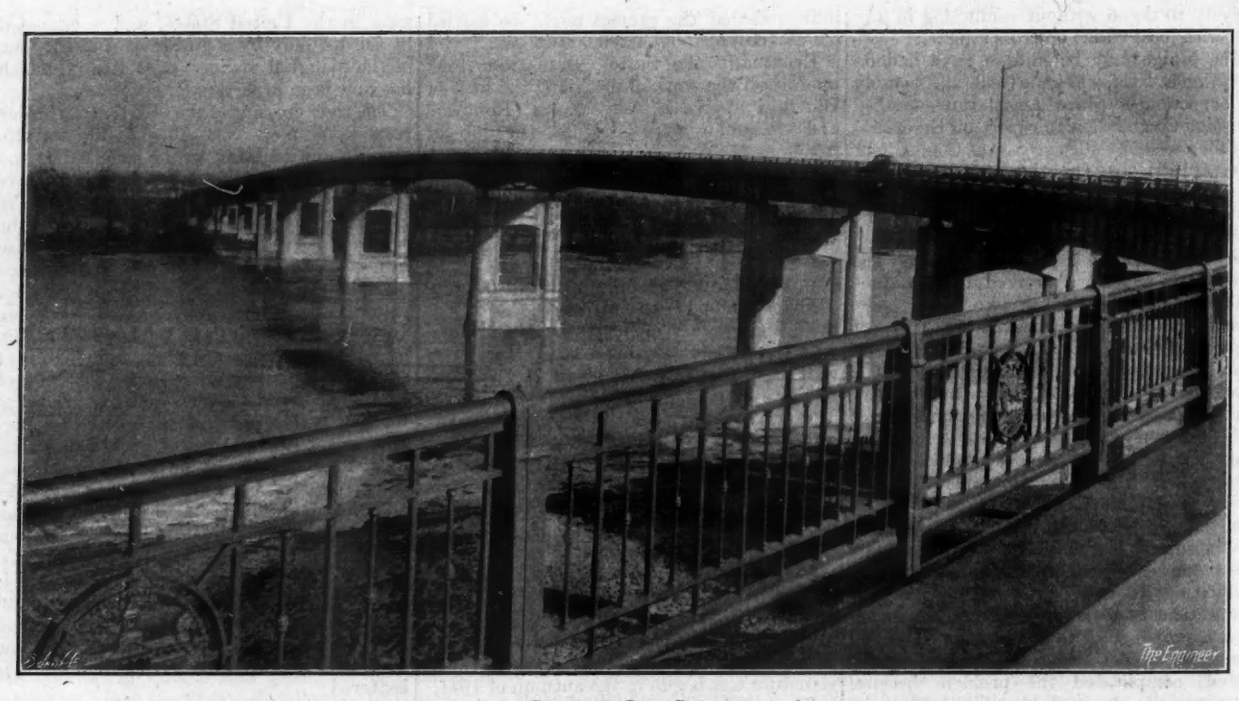


Section and Elevation of Bridge at Pier

The floor beams have a depth of 5ft., with $\frac{3}{8}$in. web plates, and with flanges, top and bottom, formed of two 6in. by 4in. by $\frac{9}{16}$in. angles. The stringers resting on the main deck beams are 21in. wide-flange, 59-lb. I beams, and upon the stringers are placed the floor slabs of the roadways. These consist of 4½in. I beam Lok grid work filled with concrete. The steel grid is laid directly on the stringers and without steel underpans. The mall between the two roadways is of bent steel plate and of welded construction. The mall has a width of 4ft. and a height of 1ft. 9in. The kerb on the outer side of each roadway is also of $\frac{3}{8}$in. steel plate, welded, and carbon steel. On the straight or uniform run of 11ft. 6in. in depth the web plate has a thickness of $\frac{9}{16}$in., but is increased successively to $\frac{5}{8}$in., to $\frac{11}{16}$in., and finally to $\frac{3}{4}$in. at piers Nos. 13 and 14. The two plate girders of each of the spans are 40ft. apart at their transverse centres, and they are constructed of silicon steel.

A typical girder for the river spans has flanges each consisting of two 8in. by 8in. by 1in. angles at the top and two 8in. by 6in. by 1in. angles at the bottom. These four angles are placed against two side plates, 1ft. 9in. high. Along each side of the bridge there is a 4ft. walkway, with malleable iron posts and pipe railing. The pavement is of concrete reinforced with 4in. by 4in. by No. 6 gauge wire mesh. The sidewalks and a part of the roadways are supported by brackets that are secured at their inner ends to the floor beams by tension plates that pass through slots in the web plates of the girders. In the centre of the floor system, beneath the mall, there is an inspection walk.

Each end span of the river crossing consists of nine panels, each 30ft. long, and the



Charter Oak Bridge

centre span is of ten panels, each 30ft. long. At pier No. 13 the shoe is fixed, but expansion is provided for the remaining three piers. There are expansion joints for the floor at piers Nos. 12 and 15. Because of the inherent flexibility of plate girder spans, jacks were not used to measure and to adjust the reactions after erection. Instead, the desired result was obtained by the careful methods of shop assembly and erection that were employed. Also, cover plates, 100ft. long, were added in the middle of the central 300ft. span to insure against overstress that would be produced by any error in reaction.

The east viaduct of the Charter Oak bridge—also designed by Messrs. Robinson and Steinman—is of continuous construction and has a total length of 1104ft. It consists of two associate sections. The first section is composed of four spans, each 150ft. long, and the second section, also of four spans, is made up of units 125ft. long. The girders for the east approach are 10ft. deep for the 150ft. spans and 9ft. deep for the 125ft. spans. All these girders are of carbon steel. The floor construction joints are at the centre of the 150ft. spans and at 75ft. and 50ft. from the ends of 125ft. spans. All expansion takes place at the junction of the 150ft. and the 125ft. span sections of the east viaduct. The stringers of the approach spans are 18in. and 16in. wide-flange I beams of 47 lb., 55 lb., and 45 lb. respectively. The 4ft. sidewalks and a part of the roadways are carried on brackets similarly tied to the deck beams with tension plates. The roadway slabs of concrete, 7½in. thick, are built with welded reinforcing trusses, 6in. on centres.

The east viaduct is carried on reinforced concrete piers of the frame type, with the two columns tied together, top and bottom, by struts. Each column rises from a reinforced concrete base that rests on and is anchored to 14in., 73-lb. steel H sections having lengths of from 70ft. to 100ft. and driven down to rock. The tops of the piles are embedded in the concrete of the bases, and the outer line of piles around each base is battered. The east approach is over ground that is lower than on the west side of the river and the rock lies deeper, while the piers are generally higher than those on the Hartford shore. The abutment at the east end of the east viaduct has its gradient line at 49·6 and its base is at El. —3, making the total height 52·6ft. The concrete base for this abutment is supported by 14in., 73-lb. H sections that are 100ft. long. This reinforced concrete structure is of cellular construction, which permits the earth from the approach fill to spill under and around it.

The piers for the west viaduct, which were designed by the State Highway Department, are broadly similar in design to those for the east viaduct, except that the piers are generally lower, and are without bottom struts between the columns, and the supporting piles were in most cases driven without batter. On a few of the big piers of this viaduct built with a single massive base, the supporting piles were driven with a batter. The viaduct leads from the west end of the river spans either to the Hartford by-pass or to the road connecting with the highway to the Park River conduit. The latter branch from the bridge has a 24ft. roadway for one-way traffic, but with two sidewalks. The girders are 26ft. apart, and 30in. cross beams run from girder to girder. The 10in. concrete floor lies directly on the cross beams, which are 10½ft. apart. The approach to the Park River depressed highway is made up of spans 105ft. and 70ft. in length, and the girders are 6½ft. deep. The by-pass spans that carry traffic across the south meadows are simple spans, 110ft. and 95ft. in length, and the girders are 7ft. deep and of silicon steel. The 7½in. floor for these spans is similar to that used on the east viaduct.

The steel for the west viaduct, which had been lifted into position from the ground, was all in place by December, 1941, when work was started at the Hartford end of the river crossing in erecting the first of the 270ft. end spans. For the operations, the contractor was using an erection derrick built especially for the job. It had a 55ft. mast, 60ft. lay legs, and carried a 100ft. boom. The derrick was constructed of special steels and had a total weight of 176 tons. The derrick was reported to be equal to lifting a similar weight. An auxiliary traveller was employed to handle some of the steel. On December 4th, when only 48ft. of steelwork remained to be placed to close the gap between piers 12 and 13, and the erection derrick was making ready to lift and to swing forward the closing section, the single falsework bent placed between the two piers failed for some reason, and some 430 tons of bridge steel, the big derrick, the auxiliary traveller, and thirty-two workmen dropped into the river; sixteen of the men lost their lives. The falsework bent which failed was of steel and rested on a group of timber piles driven down to rock lying 50ft. below water. The piling was arranged in two groups of twenty-eight piles each, that were 65ft. long. The water was about 15ft. deep at the location and the river bottom consisted of a layer of coarse sand followed by clay with a somewhat more stable stratum of clay underlying the soft material down to the rock. The piles, which reached approximately 14ft. above low water, were capped with timber and braced. Steel grillages, upon each group of piles, provided the bases for the steel bent, which rose about 65ft. to contact the bottom flanges of the two girders of the end span. The experienced personnel of the American Bridge Company had taken all precautions believed necessary to assure ample support for the span during erection. No details have been made public disclosing the probable reason for the accident, although

Erection of Charter Oak Bridge

an investigation was made promptly afterwards by Professor Charles M. Spofford, of the Massachusetts Institute of Technology. However, the contractor made doubly sure of sufficient support by using two falsework bents when work was again started on the river crossing in June, 1942. The delay of about six months was due to difficulties in obtaining the necessary steel for the replacement span.

The two falsework bents used during the erection of the new west-end span were supported by groups of steel piles driven down to rock. One bent was placed 90ft. out from pier 12, and braced horizontally from that pier, and the other falsework bent was set 60ft. west of pier 13, and also braced horizontally to that pier to prevent any longitudinal movement. The 300ft. central span was erected with two falsework bents, also supported by groups of steel piles driven to rock. One of those bents was set 120ft. east of pier 13 and the other bent was placed 90ft. west of pier 14, the latter bent being braced horizontally from its neighbouring pier. For the east 270ft. end span only one falsework bent was used during erection, and that bent was placed 120ft. from pier 14 and supported on wooden piles. The same bents were used successively for the three spans, and no batter piles were driven.

Notwithstanding the set-back caused by the accident to the first end span, the contractor, after the replacement steelwork was delivered at the job, carried the work forward so energetically that the final span at the East Hartford side of the river was in place by August 17th, 1942.

Our Debt to the Metallurgist*

By L. W. LAW

IN many respects the fact that I cannot claim to be an eminent metallurgist and to fill such an important part in the field of metallurgy as has been done by the majority of the Presidents who have occupied the Presidential Chair in the past is a distinct handicap. But it has one great advantage, as it enables me, without laying myself open to the charge of being boastful, to pay tribute—I might almost say homage—to the achievements of metallurgists in the past few years.

Those who, like myself, have spent most of their lives in the production and distribution of machinery for agriculture, mining, transport, the preparation of food, water and electricity supply, and land drainage and irrigation cannot fail to be aware of the fact that the improvements which have been made would have been quite impossible without that ardent and unstinted support which has been rendered by the metallurgist; in fact, it can be truly said that the metallurgist must always be at least one jump ahead of the engineer, otherwise real progress is barred.

I am glad to be able to take this opportunity of emphasising how during the forty years or so that I have been connected with the industry, it has been possible for designers and makers of machinery to progress steadily and rapidly, to an extent which would have been quite impossible without the assistance, and, indeed, the very close co-operation, of the metallurgist, and to this end I might add, many members of the Birmingham Metallurgical Society have given important contributions.

Cutting Tools

In the early years of the present century, when my first experience of machine shop practice was gained, the cutting speed of cast iron was about 15ft. to 20ft. per minute, of gunmetal about 25ft. per minute, and of mild steel about 15ft. per minute. At that time self-hardening steels (containing about 6 per cent. tungsten), such as "Mushet," were in vogue, and plain cast steel tools were in common use. Nowadays with tool-cutting alloys, such as "Widia," "Cutanit," "Ardaloy," &c., cast iron and mild steel may be machined at about 400ft. per minute, and non-ferrous metals up to practically any speed which the machine will allow.

Powder metallurgy, to which further reference will be made presently, is responsible for the introduction some years ago of the tungsten-carbide cutting tool. Tungsten carbide is one of the hardest materials at our service, and also one of the most brittle. It cannot be cast or machined in the way that softer metals can be, and the solution has been to mix it in powdered form with other ingredients, then to press it into shape, and lastly to sinter it. The result is a tool which will heat to a temperature of 3000 deg. Fah., and still retain its cutting edge.

This means that the speeds at which metals may be machined have been increased by over twenty times within the comparatively short space of less than forty years. This has had a tremendous influence upon keeping down the cost of production of machinery of almost every description, and particularly of mass-produced articles, such as motor-cars and domestic appliances. Here is a very striking instance of the work of the metallurgist being of benefit to the community as a whole; it has certainly helped to raise the standard of living by bringing the cost of many articles within the reach of masses who would otherwise have been barred from enjoying the use of them.

Powder Metallurgy

One of the most recent developments of our times in connection with the application of metallurgical science is known as powder metallurgy.

The subject is of great interest to engineers, and although much has already been done, the future is likely to bring forth rapid and even astounding developments. The motor-car, aeroplane, and household appliance industries are probably the most promising fields for this new science. The reason for this is that on account of the comparatively high cost of the moulds, &c., production is only warranted when the quantities required are in the neighbourhood of 8000 to 10,000 articles. A self-lubricating bearing is perhaps the product which appeals most to the imagination of the engineer, and such bearings are already in commercial use. A motor-car door latch which never requires an oil can near it is the article which will probably have the vote of the average motoring paterfamilias, and he will say with all the fervour of which he is capable that a man has not lived in vain if the result of his labours has been to produce such a treasure. Thanks to powder metallurgy, this is now an accomplished fact.

Powder metallurgy is not new, but its development during the last few years has been almost miraculous. What formerly took several hours of a highly skilled mechanic's time can now be accomplished in a few seconds. The degree of accuracy is unimpaired, and precision down to a thousandth of an inch is obtained. To-day thousands of different components of ships, locomotives, aeroplanes, motor-cars, tanks, and radios are pressed out of powder. The smallest weighs one-twentieth of an ounce and the largest so far 65 lb. Twenty-eight different metals are now being used in this process and used in various combinations, but the experts predict that this is only a beginning of this fascinating and epoch-making branch of metallurgical science. A certain amount of work has already been carried out in connection with the centrifugal pressing of powders, and it is more than likely that further investigation and development will lead to a broader application of this process.

Aluminium

Fifty years ago there was no aluminium made in this country. It was a new metal, being produced in France, America, and Switzerland, and everything possible was done to keep the process secret. Our thanks are due to a few men of high technical qualifications and great imagination, to whose efforts we owe the fact that the manufacture of aluminium in Britain was taken up. But for their untiring efforts and enterprise, this manufacture might not have been launched here until a great deal later than it was. In 1886 the world output of aluminium was only 40 tons, and even by 1913 it had risen only to 64,000 tons. The last year for which statistics are available (1938) the output had risen to 600,000 tons, and since then there has been a further enormous increase.

Stainless Steel

Stainless steel is used now for a great variety of purposes, whilst in mining, civil and marine engineering it has proved of the greatest value, due to its resistance to the action of mine and sea water. It has been adopted for turbine blading and its resistance to nitric acid has opened up a new field for this metal in connection with the production of ammonia. In the dyeing industry the wooden vat which could only be used for one particular colour has been almost superseded by the stainless steel vat, and stainless steel is now commonly used in the milk and brewing industries, its superiority from the hygiene point of view being unchallenged.

It must not be forgotten that the welding of stainless steel introduced considerable difficulties leading to rapid deterioration in service, and it is only in recent years that weld decay-free stainless steels have been produced. Nickel, monel, and silver are also much used in chemical plants to overcome specific corrosion problems.

Oil Engines

The developments in the oil engine were only made possible by the advent of improved metals which were placed at the disposal of engineers, permitting higher speeds and higher pressures to be employed.

Here mention might be made of the use of Perlit iron for such parts as cylinder heads, liners, &c., the heat-resisting properties of which combined with its special strength, rendering it peculiarly suitable for such uses.

High-strength steels for the making of such parts as inlet and exhaust valves have been developed by the addition of other elements, such as nickel, chromium, molybdenum, vanadium, tungsten, &c., which have considerably raised the limits of fatigue strength, and also reduced or eliminated the dangers arising from mass effect during heat treatment.

For traction work and other cases where it may be desirable to keep the weight of an oil engine down to the minimum, the building up of the frame, crank case, base plate, &c., from fabricated or welded steel plates, instead of making such parts of cast iron, has been successfully accomplished.

Salt

Salt is produced in this country to a greater degree than in any other country, and from it the alkali industry has been developed to such an extent that we lead the world in this field. Our natural brine springs have been used for centuries, and it was as long ago as 1670 that men, boring for coal, discovered the rock salt deposits in Cheshire, and these have been mined ever since. Forty years is a short time, as compared with the period which had preceded it, and it is not surprising therefore that there have been no marked developments in connection with the mining of salt. The greater proportion of salt produced in this country is obtained by evaporating brine that has been pumped up to the surface from the rock salt strata through large bore-holes. The brine is run into heated open pans or tanks and the water is evaporated and the salt left.

The savings effected in this industry have been made principally by the installation of more efficient pumping plant, and by more

* From the Presidential Address to the Birmingham Metallurgical Society, September 21st., 1943.

efficient engines to drive them. Both steam engines and oil engines have been used for this purpose, and so the metallurgist can justly claim to have done his share towards such improvements as have been brought about. Naturally, the metals which come into contact with the liquids to be pumped have to be selected to resist the chemical action set up by such liquids. Examples of suitable alloys for this purpose are aluminium bronze, monel, nickel, phosphor bronze, and silicon bronze.

Water

The daily consumption of water per head of population in this country was at the beginning of the present century 30 gallons, as compared with 7 gallons per head fifty years earlier. To-day the consumption has risen to nearly 40 gallons per day per person. Birmingham and many other large provincial cities were, up to some forty years ago, well in advance of London as regards water supply; that is to say, until the Metropolitan Water Board was formed, for it was not until the year 1905 that the Board acquired the undertakings of those various private companies in whose hands the water supply of London was held until that time. The question may arise in the minds of some as to what connection there is between the metallurgist and the supply of water to large towns and cities. A visit to one of the earlier pumping stations, followed by a visit to one of the modern installations, would supply an eloquent and at the same time an adequate answer to that question. In pumping stations constructed up to forty or so years ago the machinery was almost invariably of the slow-moving push-and-pull type, with steam cylinders above and water cylinders or rams below, generally with ponderous fly-wheels, and massive beams, many of them making perhaps as few as fifteen or twenty strokes per minute. Not only was this machinery very costly to make, but the ground space occupied and the buildings required to house them were very great and costly also. The engineer, thanks in a large measure to the work of the metallurgist, has in the meantime been able so to improve his ideas and designs that the centrifugal pump has taken the place of the reciprocating pump, and it is not uncommon for these to run at a speed of 2000 r.p.m., driven perhaps by a steam turbine running at 8000 r.p.m. The consequence is that the space occupied by the pumping plant is only a fraction of that of the earlier plant, the capital cost is lower, and the resultant cost of the water as delivered to the house or factory where it is required is reduced.

The metallurgist has been to a large extent responsible for the collating of the correct metals in water pipes to ensure that potable water is available after passing through such pipes. The benefits accruing to the community in the way of health and happiness as a result of an abundant water supply cannot possibly be over-estimated, but it was not until the commencement of the present century that all London had the possibility of being clean if it wished to be. A great change for the better in the English crowd has followed from the abundant supply of water. The labourer is now clean and shaven, and his status is no longer announced by his odour.

Turbine Blades

The finding of the most suitable metals for the construction of turbine blades has been a difficult proposition, and various metals and alloys have in turn been used. Stainless steel is the one most used to-day, and recently the introduction of 1½ per cent. molybdenum to the stainless steel in turbine blades has enabled the steam pressures and temperatures to be raised from what was common practice in the year 1900, 160 lb. per square inch, to 1300 lb. per square inch, and from 400 deg. to 950 deg. Fah. The effect of this has been to raise the efficiency of the turbine to about 33 per cent., an efficiency which until lately was considered possible only with engines of the internal combustion type.

These increases in pressures and temperatures have brought many problems in their wake, and this will be appreciated when it is realised that the mean blade speed of a turbine may exceed 7 miles per minute, with a consequential tangential stress at the top of the keyway in the bore of 25,000 lb. per square inch. Further, the steam passing through the closed system of a turbine installation in a modern power station takes about 1½ hours from the time it leaves the last stage of the turbine to enter the condenser, until it re-enters the turbine again at the first stage. As compared with this 1½ hours of preparation, the time the steam takes to pass through the turbine and do its useful work is about eight-hundredths of a second.

Electric Transmission

Considerable economies in the transmission of electricity have been effected in recent years by increasing the span of overhead conductors. Three ways in which this has been brought about have been the use of:—(*a*) Copper-cadmium conductors, (*b*) steel-cored aluminium, (*c*) steel-cored copper.

For underground transmission the fatigue resistance of lead cable sheathing has been considerably improved by the introduction of small amounts of other elements, such as cadmium, antimony, and tellurium.

Transformers which play such an important part in the distribution of electricity have only been brought to their present state of perfection by the use of 4 per cent. silicon iron.

The magnetic properties of irons have been considerably improved by the addition of cobalt and, more recently, still further improvements have been brought about by the addition of nickel and aluminium simultaneously, together with special heat treatment.

Although much has been done, still more remains to be done in connection with the development of the electrical industry, and he would be a rash man who would dare to prophesy when saturation point or finality will be reached, or, indeed, if such a condition will ever arise. New fields for the use of electrical current are discovered as time goes on. And as the official figures issued just prior to the outbreak of war show that only slightly more than half the homes in this country were connected to the electricity supply, the opportunities for development in this direction alone are tremendous.

Aeronautics

The part which the metallurgist has played in connection with the rapid development of aviation cannot be over-emphasised, and some of the lines of advancement which come to mind, along which definite progress has been made, are in connection with the following:—

The age-hardening of aluminium alloys.
Aluminium-magnesium alloys.
Magnesium elektron.
Sodium-filled nickel-chromium-tipped steels for engine valves.
Nickel spark plug electrode tips.
Modified aluminium-silicon alloys.
Gravity and pressure die casting of aluminium, magnesium, and zinc-base alloys.

Figures regarding the performances of the latest aircraft are, of course, not at present available, but when hostilities cease and such figures are published there is no doubt that they will show a record of outstanding development. The vast experience gained since 1939 will have a marked effect on the whole trend of civil aviation, and one can expect that great strides forward will be made in the period immediately following the war.

Conclusion

I hope that the remarks and notes which I have made will serve to show that the metallurgist has played, and is playing, a most important *rôle* in the development of our complex civilisation, and that they may serve also, in some degree, to further the cause which I have so much at heart, a cause which it is my aim to further as much as is possible during my term of office, namely, the improvement of the status of the metallurgist.

It has been truly said that without mechanical engineering our whole social structure would collapse, and I would add that without metallurgical science mechanical engineering would collapse. Fortunately, both are with us, stronger and healthier than ever before, one helping and guiding the other, and just as Nature in her great wisdom has ordained that the dock leaf shall grow adjacent to the nettle, so fortunately has man arranged things so that the metallurgical industry shall grow side by side with that of mechanical engineering. It is always there to help us to surmount our difficulties and to get us out of at least some of our troubles whenever we call upon it to do so. Long may the two industries go forward together to conquer fresh fields to the ultimate benefit of the community they serve, for, as Kipling rightly said: "Everything in life from marriage to manslaughter turns on the speed and cost at which men, things, and thought can be shifted from one place to another."

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

"THIS FREEDOM"

Sir,—I, too, would be glad of the opportunity to follow Mr. Chambers' admirable lead and congratulate you on the first-rate leading article in The Engineer of September 10th.

It needs courage at the present time to speak publicly in praise of individualism, and all engineers should be thankful to see this heartening and encouraging contribution to the vital cause of personal freedom.

The letter from Mr. Wüthrich in your issue of September 24th is as interesting and readable as it is melancholy, and great is one's surprise to find it written by a Swiss. I have always shared the English admiration for Switzerland, that shining exponent of the art of putting freedom into practice.

More especially do engineers feel this admiration for Mr. Wüthrich's country. Where would her engineering products, which range from the heaviest to the most delicate, and are among the highest in their class, have been but for free personal enterprise?

Surely free enterprise is the one and only way to bring what Mr. Wüthrich so picturesquely calls the "bread-basket" into any reasonable reach of the inhabitants of this earth.

It is a fact that exceedingly few people are willing to take risks or responsibilities. Yet, without someone to carry these burdens, the bread-basket will never be reached. This fact is woefully little realised. The bread-basket is not a finished product of Nature. Nature's bounty is endless, but in the raw it is decidedly uneatable and lacking in comfort.

Free enterprise allows the few to go ahead, bear their anxieties, take their risk of failure. The successful ones create the force which pulls the bread-basket within reach. Then it can be shared by the majority who shy from responsibility, but who earn their share by a willingness to undertake a steady output of plain work.

There will, on this earth, always be difficulties and inequalities. But for men to be free, under the guidance of moral law, is the only way on which they can even begin to smooth away these troubles.

Above all, free men work in the light, exposed to their neighbours' comment and criticism. Bureaucracy and all forms of collectivism inevitably function in the terrible darkness of anonymity.

Lawrence Lindsay.

Queen's Road, Bradford, Yorks,
September 25th.

Canadian Non-Ferrous Metal Production.—Canada increased its output of refined copper from 232,000 tons in 1939 to 270,600 tons in 1942; refined lead, from 191,000 to 243,800 tons; refined zinc, from 175,600 to 216,000 tons; and refined nickel, from 64,500 to 93,300 tons.

The Engineer

OCTOBER 1, 1943

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THE SPREADING OF KNOWLEDGE

ON another page may be found a report of the address which Mr. J. G. Crowther, Director of the Science Department of the British Council, delivered at a recent conference organised by A.S.L.I.B. It may be of service to recall that the British Council was founded in 1934 at the instance of the Foreign Office on representations made by Diplomatic and other Missions to foreign countries. Under the terms of its Charter (1940) its duty is to promote a wider knowledge of the United Kingdom abroad and to develop closer cultural relations between this country and others for the benefit of the British Commonwealth. The Council is mainly supported by a grant carried in the Foreign Office Vote. In harmony with the spirit of international brotherhood which is to be fostered after the war, Mr. Crowther, speaking for the Council, took an extended view of the wide dispersal of knowledge. He did not centre his arguments on matters directly affecting the benefit of the British Commonwealth of Nations, but took the whole world in review.

His theme was "the efficient organisation and use of scientific information." He asked if our statesmen fully realised its importance and if they were prepared to provide the means by which the most expert bibliographers could make scientific information readily accessible for the benefit of humanity. His answer to that question was so far from being encouraging that he deemed it desirable that the Prime Minister should form a Cabinet Committee "to study the matter and inspire the preparation of suitable plans." In his view there should exist in Britain a service which could give rapid and critical answers to any requests for books and periodicals. It should be provided with a vast card-index, each card containing a brief review of the work it recorded. Furthermore, he held that the centralisation of abstracting services was desirable. "Instead of separate scientific institutions in each country trying to abstract the world literature in any particular sphere, all abstracts relating to a special subject should be pooled and one comprehensive internationally compiled abstract journal should be published in all important languages." Mr. Crowther recalled with approval Mr. Ritchie Calder's plan for an Institute o Scientific Information, which would supply journalists and others with information which would be "instructive without being dull, and accurate without being pedantic," and he concluded by quoting the opinion of Dr. Arnold Raestad, of Norway, "that in reorganising the world, the United Nations have no more fundamental task and no more urgent one than to implement a proper international co-operation in the adequate presentation of the results and methods of science to the peoples of all countries."

To know where to look for information is the beginning of knowledge, not its end. Indexing, however complete, cannot take the place of study. It is no more than an essential adjunct to a library. Abstracts are in the same case. They are of use to the expert who is in a position to read between the lines, but may be actually dangerous in the hands of the unitiated. Pope's saw about "a little learning" is very true of them. Hence it may be said that neither index nor abstracts can do much to expand knowledge amongst those who are not already fairly well informed. The inestimable value of indexes to experts is not questioned for a single instant; but if more is to be attempted towards the dissemination of scientific knowledge amongst the public something further is required. Mr. Ritchie Calder's plan for an Institute of Scientific Information would seem to approach the desideratum, even though we may question if it be possible to present information on all the subjects of science without being dull—to the general public—and "accurate without being pedantic." Yet much, very much, has already been achieved. Every encyclopedia generalises knowledge, there have been many examples of "popular educators," and there are many books—some of the most recent in Basic English—which popularise several of the sciences. Furthermore, there are periodicals which cater especially for readers who are in search of general scientific knowledge, and the B.B.C. and the screen are not neglectful of their duty in this respect. Indeed, it may be said that the sources of knowledge already exist. What is required now is to expand those sources and to encourage the people to drink at them. Particularly is it desirable that false science should not be allowed to get into circulation. There the daily papers are serious offenders. They are often more attracted by the sensational than the accurate. We hope to see the day when everyone of them has on its staff a qualified scientific editor as it has now a City editor or a sports editor. They have a great opportunity in a world which is becoming more and more scientific minded. Reaching millions they can do far, far more to expand a general acquaintance with science than text-books which are acquired by only a few thousands. With the new sense of responsibility and service they may we hope rise to their duty in this respect.

The German Air Defence

FORCED to the defensive, the German Air Force now seeks salvation by turning over a great proportion of its constructive effort from bombers to fighters, and hunts earnestly for new expedients to enhance the efficiency of that defence. Its aircraft building capacity has had to endure increasingly devastating blows from the Allied Air Forces and its scope is by no means what it was, but whatever may be its present output in tonnage per month, its numbers can be more easily sustained when the main effort is to build fighters rather than bombers, since fighters are so much smaller and weigh so much less. Hence we need not be surprised that this much weakened Air Force can put up fighters by the hundred when it is sufficiently hardly pressed, though they will not normally "look for trouble." The enemy tries to protect his industrial areas by so grouping his night fighters that they can be diverted to the defence of any point in their neighbourhood that is threatened, but with so large a territory to cover this is no simple matter.

In certain cases recently the enemy has given evidence that he is so dissatisfied with the toll he has taken of our night bombers that he is seeking desperately for new tactics. Naturally, no rate of loss he can inflict which fails to be clearly deterrent can satisfy him. He normally expects to locate our bombers by one of the many variations of radio detection, but it seems that he does not find this method satisfactory, owing possibly to supply difficulties in the equipment of his fighters, or because the apparatus is inefficient or too complicated or too easily gets out of order. Whatever the reason may be, he is trying once again the method of direct vision. This calls for the use of searchlights or flares. Searchlights he has no doubt, with limitations, found useful, but as they cannot penetrate cloudy skies, he has lately taken to releasing quantities of very powerful flares from a great height over the target, so making

an effort to turn "night into day." But whilst these flares light up the bombers, they have also the awkward result of illuminating both the target city, hitherto so carefully "blacked out," and the night fighters themselves. The whole plan must in fact be looked upon as a desperate remedy for a desperate situation. The enemy no doubt hopes that his gains will outweigh his losses, and one may assume that his ultimate object is to make the night bomber unsafe in this artificially created "daylight." If he could compel his opponents to use day bombers only for night attacks he would no doubt cause the tonnage of bombs he has to endure to be substantially reduced, since much of the load of a day bomber has to be given up to the provision of guns and armour; the gun power of a "Fortress," for example, is five times as great as that of a "Lancaster," and needs to be. Even in the improbable event of this attempt succeeding, the gain could not be all one way, for with the enemy night fighters well lit up the execution levied on them by the greater gun power of day bombers might well prove as critically great as it has so often been in the daylight raids by "Liberators" and "Fortresses." Moreover, the general lighting up of the target—so blessedly floodlit—must so greatly facilitate the finding of the precise objectives under attack as to be a grave disadvantage to the enemy.

In discussing this move on the enemy's part one can but guess at his motives and his hopes, and one must remember that it is only over the target area itself that this kind of flood-lighting can be managed. From the bombers' point of view, therefore, it is a night operation almost the whole of the way out and back, and its "daylight" interlude is only whilst near the target. Moreover, the flares must need be very bright and very numerous if they are to light up black-painted aircraft with anything like the efficiency with which they will light up the ground target. One must conclude that since the time during which the bomber can be rendered visible is so small a proportion of the whole time of the raid, the price paid in making the target much more easily identifiable, and in the greater hurt likely to be inflicted on the defending night fighters, is likely to prove far too high to make it a profitable venture. The expedient has interesting technical features, but is not one which can delay the inevitable consequence of our increasingly heavy attacks by air on the German war industry wherever it is or may be located.

Obituary

JOHN JOB CREW BRADFIELD

Australia has lost one of her leading civil engineers by the death, recently reported from Sydney, of Dr. John Job Crew Bradfield, the senior partner of Dr. J. J. C. Bradfield and Son, consulting engineers. He was responsible for the drawing up of the specifications for the construction of the Sydney Harbour bridge in 1923, and for many years was the representative of the Institution of Civil Engineers in Australia. He carried out many important engineering works in Australia, but was well known in this country, where he had many friends.

Dr. Bradfield, who died at the age of seventy-five, was the son of the late Mr. J. E. Bradfield, and was born at Sandgate, Queensland. He received his early education at the Grammar School, Ipswich, Queensland, and gained the Queensland Government Exhibition. He went up to Sydney University, where he had a distinguished academic career. He was awarded the Levy Scholarship for Chemistry, the Sulman Prize for Architecture, and the Smith Prize for Physics. He obtained his Bachelor of Engineering Degree with a Gold Medal and his Master of Engineering with the University Medal, and finally took his Doctor of Science of Engineering Degree. He received his practical training in the Government Railway Department, Brisbane, Queensland, and later served with the Roads and Bridges Branch and the Railway Construction Branch of the Public Works Department, Sydney, New South Wales. He will long be remembered for the important part he took in reviving the proposal for the construction of a bridge across Sydney harbour. For well over a hundred years proposals for the construction of such a bridge had been made by various parties. In 1900 the proposals began to take definite shape, in so much that in that year the New South Wales Government invited competitive designs for a bridge. Numerous schemes were submitted, but in the end no contract was let. In 1911 and 1912, after a prolonged inquiry, the Public Works Committee recommended that a cantilever bridge should be built from Dawes Point to Milsons Point, in order to provide the roadway accommodation required to link the city with its rapidly growing residential area on the opposite side of the harbour and to carry the City and Suburban Railway. Some ten years later, in 1922, the Government of New South Wales passed an Act authorising the building of a bridge across the harbour. In 1923 the Government invited tenders for the construction of a bridge in accordance with a project and a specification prepared by Dr. J. J. C. Bradfield, who was then Chief Engineer of the New South Wales Public Works Department. Dr. Bradfield's specification referred particularly to cantilever and arch bridges. It defined the situation and the principal requirements and laid down the length of the main span and of the approaches and the navigation clearance under the deck. In addition, it described the disposition and dimensions of the railway, roadway, and footway tracks, and the loads for which the bridge was to be designed. The specification also outlined the degree of responsibility which the contractors were required to undertake. The response was an international one, and designs and tenders, covering in all twenty proposals, were submitted by some of the world's leading bridge-building firms in response to the invitation of the Government. In March, 1924, we may recall, the contract was awarded to Dorman, Long and Co., Ltd., the accepted tender being for an arch bridge, one of seven proposals submitted by the firm. These proposals and the designs covering them were prepared by Mr. Ralph Freeman, of Freeman Fox and Partners. A full account of the building of this bridge will be found in The Engineer of March 18th, 1932, and the subsequent issues up to April 9th, 1932. Dr. Bradfield's own account of the bridge will be found in a paper he read before the Institution of Civil Engineers in April, 1934, when papers on other aspects of the bridge were read by Mr. Ralph Freeman, Mr. Ralph Freeman and Mr. Lawrence Ennis, and Mr. J. F. Pain and Mr. Gilbert Roberts.

Dr. Bradfield was closely connected with Sydney University as a lecturer and examiner in engineering subjects, and as a Fellow of the Senate since 1913. He was a member of the Australian National Research Council. In 1902 and again in 1919 he was President of the Sydney University Engineering Society. He took a keen interest in the work of the Institution of Civil Engineers in Australia, and was since 1917 a member of the Advisory Committee of New South Wales. He took a leading part in the drawing up of the constitution of the Institution of Engineers of Australia, and served on its Council. He was a member of the Board which established the first Civil Aviation School in Australia at Richmond in 1916, and during the last war he was a member of the Patents Investigation Board. From 1936 to 1939 Dr. Bradfield was the Australian Representative on the Council of the Institution of Civil Engineers. He was the recipient of many honours including the Peter Nicol Russell Medal of the Institution of Engineers, Australia, the Kernot Memorial Medal of the Melbourne University, and the Telford Medal of the Institution of Civil Engineers. In 1933 Dr. Bradfield's work was recognised by the bestowal of the C.M.G. In 1938 he was elected President of the Royal Geographical Society of Queensland. In his long engineering career Dr. Bradfield wrote articles on many subjects, among which were "Australian Timbers," "The Spit and Manly Tramway," "Traffic Problems of Greater Sydney and Town Planning," and the Reports, "City and Suburban Electric Railways" and "Linking of Sydney with North Sydney," and also the paper on the "Sydney Harbour Bridge," already referred to.

ALFRED SMALLWOOD

It is with much regret that we learn of the death of Mr. Alfred Smallwood, at his home at Handsworth, Birmingham, on September 14th. His death, at the age of eighty-nine, is a loss which will be felt throughout a wide sphere of metallurgical and industrial interests. His introduction to the metal trade began in Birmingham at the early age of twelve. Despite the prevailing conditions of long hours and extreme physical effort prevailing in those days, he acquired a sound technical education and in early manhood acquired proprietary interests in both the non-ferrous casting and seamless steel tube trades. He did much pioneer work in the manufacture of bearing metals and phosphor-bronze, and in the early part of this century founded the Incandescent Heat Company, Ltd., industrial furnace manufacturers, Buckley's, Ltd., seamless steel tube manufacturers, and more recently Boulton Tubular Structures, Ltd., Selas Gas and Engineering Company, Ltd., Manchester, Controlled Heat and Air, Ltd., Smethwick, and other engineering companies. He had many and diverse interests both at home and abroad, having travelled extensively throughout Europe, America, and Africa. He was a man of generous heart and mind, and his success enabled him to exercise a philanthropy little known to others than the recipients. He supported many important researches. Of retentive memory and large experience, he retained an active interest in life and remained in full mental vigour to the last.

BOOKS RECEIVED

Machine Shop Year Book and Production Engineers' Manual. Edited by H. C. Town. London: Paul Elek (Publishers), Ltd., Africa House, Kingsway, W.C.2. Price 30s. net.

A Universal Resonance Chart

By H. G. YATES, M.A.*

DURING a recent survey of the properties of simple resonant systems, the writer came across a point which seems to have escaped comment in the literature of the subject. The systems referred to comprise a mass m in an elastic restraint of stiffness s, together with viscous damping characterised by a constant r.

Under the action of a sinusoidal driving force of amount F and frequency f, the equation of motion is

$$m.d^2x/dt^2+r.dx/dt+s.x=F.\cos 2\pi ft \quad . \quad . \quad . \quad (1)$$

The steady-state solution of this is usually given in the form

$$u=dx/dt=\frac{F}{Z}.\cos(2\pi ft-\phi) \quad . \quad (2)$$

where Z (the mechanical impedance) is given by

$$Z^2=r^2+(2\pi fm-s/2\pi f)^2 \quad . \quad . \quad (3)$$

and

$$\tan\phi=(2\pi fm-s/2\pi f)/r \quad . \quad . \quad (4)$$

Resonance occurs when Z has a minimum value, and this takes place when $f=\frac{\sqrt{s/m}}{2\pi}=f_o$, say. Now write

$$2\pi f_o m/r=Q \quad . \quad . \quad . \quad . \quad (5)$$

where Q will be called the selectivity factor. This gives

$$\tan\phi=Q.(f/f_o-f_o/f) \quad . \quad . \quad (6)$$

which enables ϕ to be derived fairly simply.

In mechanical vibration work it is perhaps more usual to measure the damping by the logarithmic decrement, which is expressible in the present notation by π/Q, assuming that Napierian logarithms are used. However, the writer prefers the Q notation, for the following reason.

At resonance $Z=r$, and the amplitude of the velocity response is therefore F/r. Hence the maximum deflection at resonance is $F/2\pi f_o r$, which may be written in the form $Q.F/s$. But F/s is the static deflection which would be produced in the system at rest by a steady force of amount F. Thus the number Q may be considered as a stress magnification factor, expressing the ratio of the stress produced by a vibrational force at resonance to the steady stress produced by a constant force of equal magnitude.

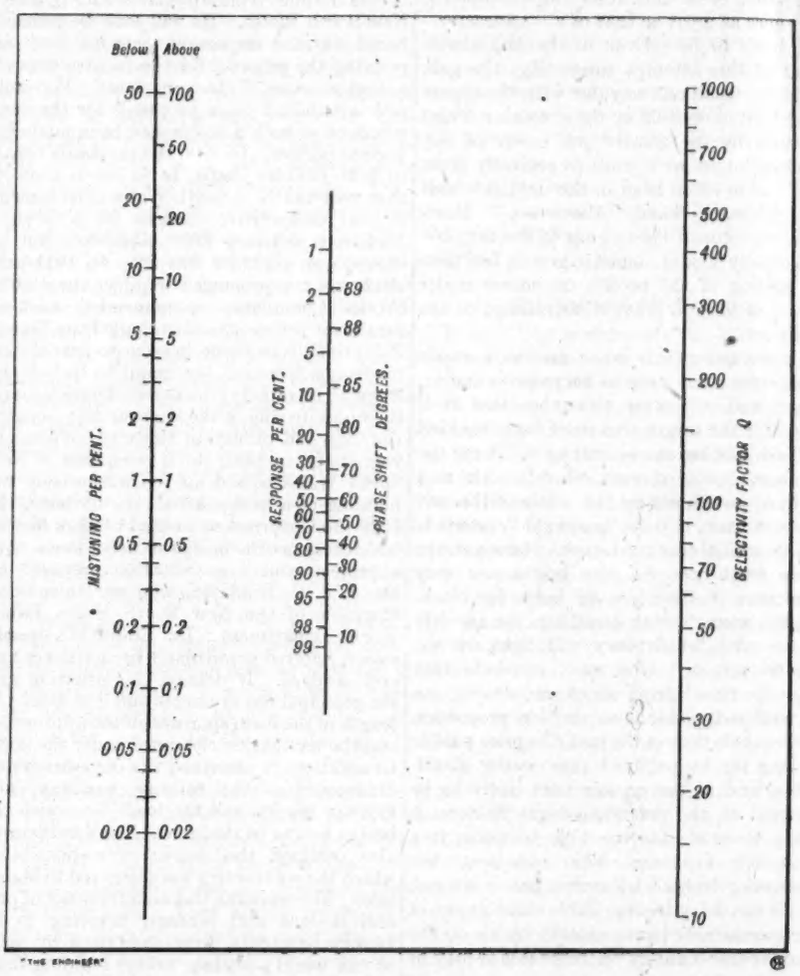
Incidentally, a slightly different procedure is usually adopted in radio work, where Q is defined as $2\pi fL/R$ (the inductance L corresponding to the mass m and the electrical resistance R to the damping constant r). However, the radio-frequency resistance of a coil varies with frequency and is approximately proportional to it (the losses in the condenser are generally negligible). Consequently Q becomes $2\pi f_o L/R_o$, which is equivalent to the definition adopted in the writer's notation. It is found by experience that Q is fairly constant for a given coil over a wide range of frequencies.

All the foregoing is well known, but the fact whose significance, so far as the writer can discover, has not been commented upon is that Z may be written as $r/\cos\phi$ instead of being given in the more cumbersome form of equation (3). With this simplification the response, in terms of the response at resonance, may be written simply as

$$u/u_o=\cos\phi.\cos(2\pi ft-\phi) \quad . \quad (7)$$

Thus, as soon as the phase shift ϕ has been calculated from the simple expression (6), the response may be obtained from a table of cosines. Furthermore, the information contained in equations (6) and (7) may be conveniently represented by the simple nomogram or alignment diagram shown in the attached figure.

The scales along the line on the left-hand side of the chart represent the percentage mistuning, *i.e.*, the difference $f-f_o$ expressed as a percentage of f_o, one scale relating to values of f below f_o and the other to values above it. The right-hand line carries a scale of Q values, while the scale on the left of the middle line gives the response as a percentage of the response at resonance and that on the right of the middle line the corresponding phase shift.



To use the chart, join with a straight-edge the desired percentage mistuning on the left-hand line to the required value of Q on the right-hand line. The point of intersection with the middle line gives immediately both the percentage response and the phase shift.

The chart has several advantages over the universal resonance curves generally used (*e.g.*, Terman, "Radio Communication," second edition, page 56). First, its use requires no preliminary calculation whatever. Other forms of resonance curve generally require the multiplying of the degree of mistuning by the Q factor before the result can be obtained. Secondly, the chart is accurate for any value of Q, no matter how large the range for which it is drawn. Thirdly, the convenient way in which the response scale opens out at both ends makes it possible to cover a very large range while still retaining high accuracy at the interesting parts of the range. The chart illustrated covers response values between 1 per cent. and 99 per cent., whereas resonance curves cannot usually go below about 20 per cent. without sacrificing accuracy higher up.

If desired, a scale of logarithmic decrements may be placed on the right-hand line alongside the Q scale, but this has been omitted from the illustration for the sake of clearness.

Another point, of particular interest in mechanical vibrations, is worth mentioning. It has been shown that at resonance the stress magnification is Q. At a frequency f, off resonance, the velocity is reduced in the ratio $\cos\phi$ and the deflection in the ratio $\cos\phi.f_o/f$. Consequently the stress magnification is $Q.\cos\phi.f_o/f$. Now, when appreciably off resonance, $\cos\phi$ is very nearly equal to $1/\tan\phi$. Hence the stress magnification is given by $\frac{f_o/f}{f/f_o-f_o/f}$ and is independent of Q. Thus damping has no effect on the stress magnification factor except in the vicinity of resonance.

It is, in fact, remarkable how close to resonance one must go before damping begins to have an appreciable effect. Most mechanical systems have Q values between 30 and 3000 (logarithmic decrements between 0·1 and 0·001 approximately). For any

* Turbine Research Engineer, English Electric Company, Rugby.

value of Q within this range the stress magnification is almost exactly 10 at 5 per cent. off resonance, while at Q=10 the factor is still as high as 7 approximately, although for such a low Q the maximum possible stress magnification factor is only 10.

Consequently, if a mechanical system is to be safeguarded from the effects of vibrational forces by tuning, *i.e.*, by keeping the resonance frequency removed from possible exciting frequencies, then damping is of negligible assistance. If tuning is not possible then the system must be sufficiently damped to make it safe even at resonance.

Laboratory for H.T. Research*

THE Oerlikon Company, which has been carrying out tests for some ten years with surge-producing condensers, installed in 1938 a 1,250,000-volt surge generator with an energy content of 7·8 kW sec., with which systematic tests on all products were started. As more and more information was collected regarding the nature of atmospheric surges, it became possible to deal with the problem of producing a protective device against surges which would be reliable in service. This problem touches both the problem of insulation and that of switching. As the 1·25 million volt surge-producing condenser of the Oerlikon Company had also to serve for development work on lightning arresters, it was erected temporarily, in 1938, in the entrance hall of the high-power testing installation. Thus, the lightning arresters could be subjected to the combined stresses of the surge generator and of the short-circuit generator. In 1939 the surge generator was enlarged so as to give 2,000,000 volts, with an energy content of 12·5 kW sec.; it was placed at the disposal of the Swiss National Exhibition of 1939 in Zurich for six months. During this time it was used for showing to visitors the effect of artificial lightning, in the H.T. laboratory of the Exhibition. After the closing of the Exhibition it was necessary to find at the works a new place for installing this considerably enlarged surge generator. The Oerlikon Company decided then to bring together all the available and newest equipments for H.T. research and to install them in a building specially erected for the purpose—the new H.T. laboratory.

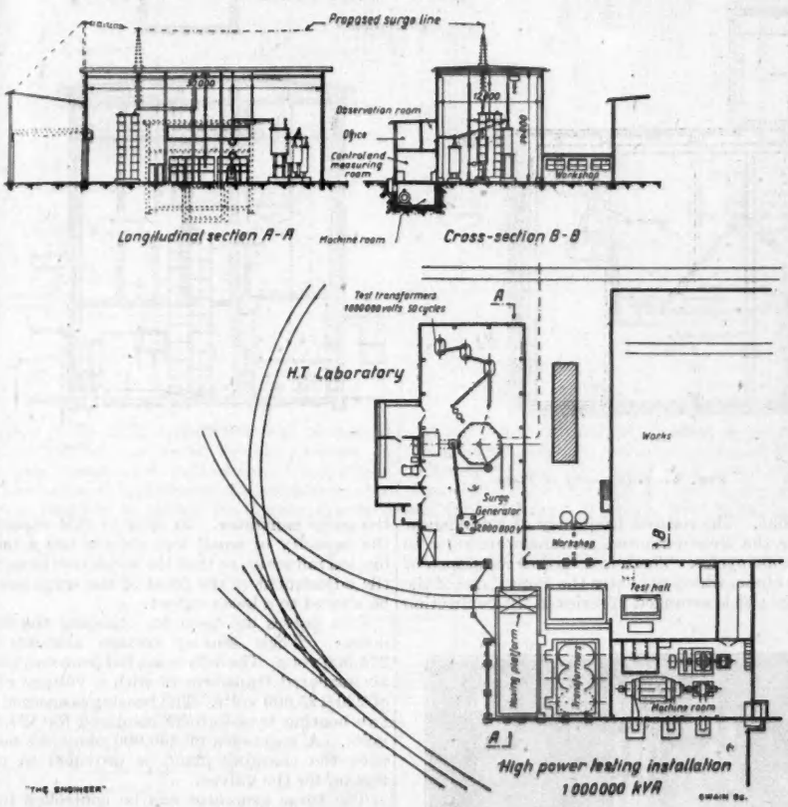


FIG. 1—*Section and Plan of Laboratory*

Arrangement of the H.T. Laboratory

The main equipments which the H.T. laboratory had to accommodate were three test transformers connected in cascade for a maximum voltage of 1,000,000 volts at 50 cycles and the surge generator for 2,000,000 volts. The floor surface required by these was 30 m. by 13 m., with a height of room of 14 m. As previously mentioned, this room had to be as near as possible to the high-power testing installation (see plan in Fig. 1), in view of the combined tests which were necessary for lightning arresters in particular. A site was selected at the north-western end of the high-power testing installation, which suited the local conditions and met the building regulations. The building is arranged with its longitudinal axis perpendicular to the longitudinal axis of the high-power testing installation, in such a way that the railway siding of the latter and its 15-ton crane can serve for both installations; communication is provided between the two by a door 5 m. wide that can be closed by means of a roll shutter and through which a track leads from the unloading place of the crane to the H.T. laboratory. The 50-cycle test plant was installed at the northern end and the surge-producing equipment at the southern end of the test room, so that there was space available in the centre for the common measuring spark gaps with spherical electrodes having diameters of 1 m. and 50 cm. respectively, for the object to be tested and for a large oil tank for tests under oil.

The control and measuring equipments, as well as the newly installed double cathode ray oscillograph, are accommodated in an extension built on the western side of the hall. The H.T. switching equipment and the converter set for feeding the 50-cycle test plant were placed in the basement of the extension, so that in the hall itself there are no external noises liable to interfere with the detection of flash-overs on the objects tested. Two roomy offices are provided on the first floor, for the test engineers, with an observation gallery open towards the hall, where visitors and observers can safely stay.

The plant supplying the voltage for the surge generator consists of two potential transformers, two rectifier valves, and two heating current transformers; these are accommodated in the south-western corner of the hall.

In the yard bounded by the high-power testing installation the H.T. laboratory and the metal foundry it was possible to set aside a space of 10 m. by 4 m. for a workshop, which serves for the erectors both of the high-power testing installation and of the H.T. laboratory.

A small electric travelling crane with a lifting capacity of 1·5 tons is provided for handling the smaller objects to be tested and for altering the connections. Heavier objects are brought to the middle of the hall on a truck.

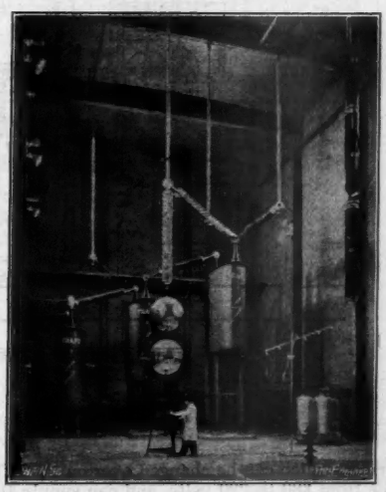


FIG. 2—*Test Transformers for 1,000,000 Volts, 50 Cycles*

Equipments and Connections

The new hall is intended in the first place for H.T. research. For the customary tests with 50-cycle voltage there are other test transformers in the corresponding departments of the works. Facilities have, however, been provided for permitting the supply of voltage from the H.T. laboratory to these different departments by means of an overhead line. Very large objects can also be tested on the railway track in front of the hall.

The arrangement of plant, &c., can be seen from Fig. 3. The building itself is of wood. Apart from the saving in steel secured thereby, there are the special advantages resulting from the absence of protective earthing. The extension for the measuring rooms and offices is, on the other hand, built with walls of masonry work. The test hall has no windows at all, but there are large ventilation flaps. The measuring rooms have windows, but these can be darkened. Provision is made for heating by air circulation.

The three series-connected testing transformers for 1,000,000 volts, 50 cycles (Fig. 2) have a total capacity of 1200 kVA. In order that they should be quite independent of the system, with regard to voltage regulation, wave shape of pressure, &c., they are fed by a 360-kVA motor generator set; the synchronous generator of this set has a laminated rotor with distributed

* From *Oerlikon Bulletin* No. 236.

excitation winding and with damping winding (see diagram in Fig. 5). This method of feeding the test plant presents the advantage that the system of the works is always loaded on three phases. The motor is connected to the 6300-volt H.T. system through a 320-kVA transformer, which can be changed over on the L.T. side from 380 to 220 volts, and can supply the test room with low tension for tests of various kinds.

The currents to be supplied by the testing transformers during the pressure tests are capacity currents. In order to relieve the generator, two induction coils are connected in parallel with the testing transformers; they are so dimensioned that their lagging currents compensate the leading test currents. The generator has therefore to supply, in the case of the most favourable equalisation, only the watt current. One of the two coils has a fixed iron core and, consequently, a fixed inductive current consumption. The air gap of the other coil can be regulated by remote control, so that in the case of each test, adjustments can be made for minimum generator current.

All control, measuring, and signalling devices for the 50-cycle test plant are arranged on a desk, which is mounted in front of a window of the measuring room in such a way that the test engineer can see the whole hall. He can, furthermore, lift up the sliding window in order to be able to check also the sounds (Fig. 7).

The surge generator for 2,000,000 volts (see Fig. 4), which was supplied by Emil Haefeli A.G., Basle, consists of sixteen condenser units, each designed for 0·1 μ farad and a maximum charging voltage of 125 kV. These condensers are accommodated in oil-filled bakelite cylinders. These are arranged one above the other with insulating cylinder of same diameter in between, thus forming columns 8 m. high.

The condensers are connected together in accordance with the Marx system. In the middle, between the four columns, there is a shaft carrying the movable sphere of the adjustable operating spark gaps of the sixteen voltage steps. The charging resistances are embodied in the connecting-rods fitted externally to the columns, while the damping resistances are in the connections to the spark gaps. The loss angle of the condensers is, at 20 deg. Cent., smaller than 0·0025 and, at 60 deg. Cent., smaller than 0·0035. The natural frequency of a condenser over the short-circuited terminals amounts to 300,000 cycles. There is a further resistance of 600 ohms, which regulates the frontal rise of the surge; it is arranged in series in the connection to the object to be tested and to the measuring spark gap. The discharge resistance in parallel with the object to be tested and with the spark gap is made of two types. One of the types of resistances consists of low inductivity resistance strip secured to a bakelite tube, while the other is a capacity shielded resistance, as evolved by Dr. Berger; the latter is built up of units for 1440 ohms and for a surge voltage of 175,000 volts, as required. The protective capacity of this resistance acts also as capacity load for the surge generator. In view of this capacity the capacity of small test objects has a more limited influence, so that the series resistance for the adjustment of the front of the surge has to be altered to a lesser extent.

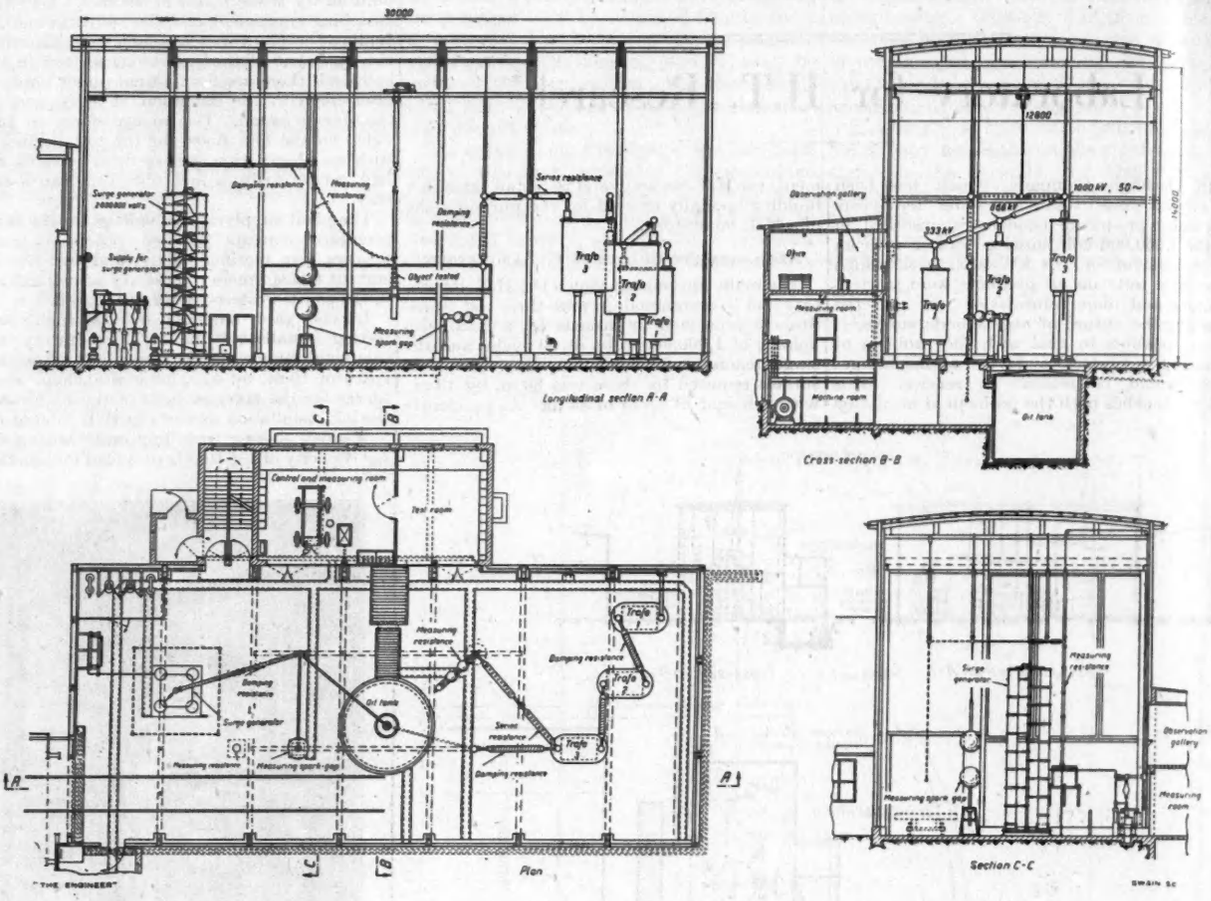


FIG. 3—*Arrangement of Plant*

Two valves are used for charging the condenser. Their sealing voltage amounts to 275,000 volts. The valves are fed from two small air-insulated transformers with a voltage ratio of 220/125,000 volts. The heating is ensured by two heating transformers insulated for 125,000 volts. A resistance of 400,000 ohms, in series with the charging plant, is provided as protection for the valves.

The surge generator can be controlled from four different points by means of a small movable switch desk (Figs. 4 and 7), viz., from the interior of the measuring room, from a point in the test hall itself, from the control room, and finally from the test room of the high-power testing installation.

Points are provided at these four places for connecting up the movable switch desk. The voltage and heating can be regulated by means of sliding resistances, while the switching spark gaps of the surge generator and the measuring spark gap for measuring the voltage can be adjusted through their remote control gear by push buttons. The setting of these spark gaps can be read on large figure sheets, visible from a distance.

Very special attention has been paid to the earthing. For the surge earthing four steel piles, 7 m. long, were driven into the ground immediately below the surge generator, and connected together. A separate earth line was led from the test site to below the surge generator, in such a way that the current loop of the surge current should be minimum. For the frame earthing a band electrode was laid in the

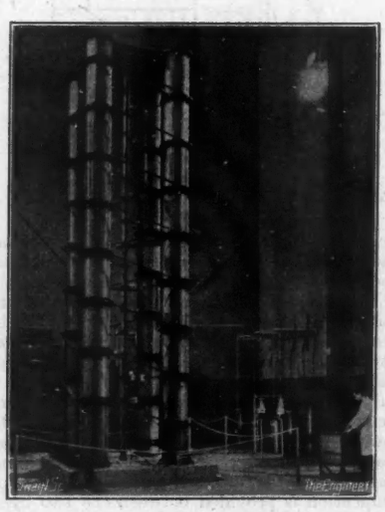


FIG. 4—*Surge Generator for 2,000,000 Volts*

ground right round and parallel with the walls of the building on the inner side. This earthing was first of all kept separate from the surge earthing; it had, however, various visible and detachable connecting points. Furthermore, as a measure of safety, the extensive lighting system of the H.T. installation was connected to the rest of the works system through an isolating transformer. Apart from the question of insulation, this presented the advantage that it was possible to adopt the higher standard voltage of 380 volts already in use in that part of the works.

As the cathode ray oscillograph, which the Oerlikon Company already had, was constantly required for the rupturing tests in the high-power testing installation, the H.T. laboratory was equipped with a double cathode ray oscillograph. This oscillograph, built by Trueb, Tauber and Co., of Zurich, to the design of Dr. Berger,† of the F.K.H., has two discharge valves, which are built in the same vacuum on the same container thus making it possible to obtain oscillograms of two different electrical processes, independent of each other, on the same photographic film.

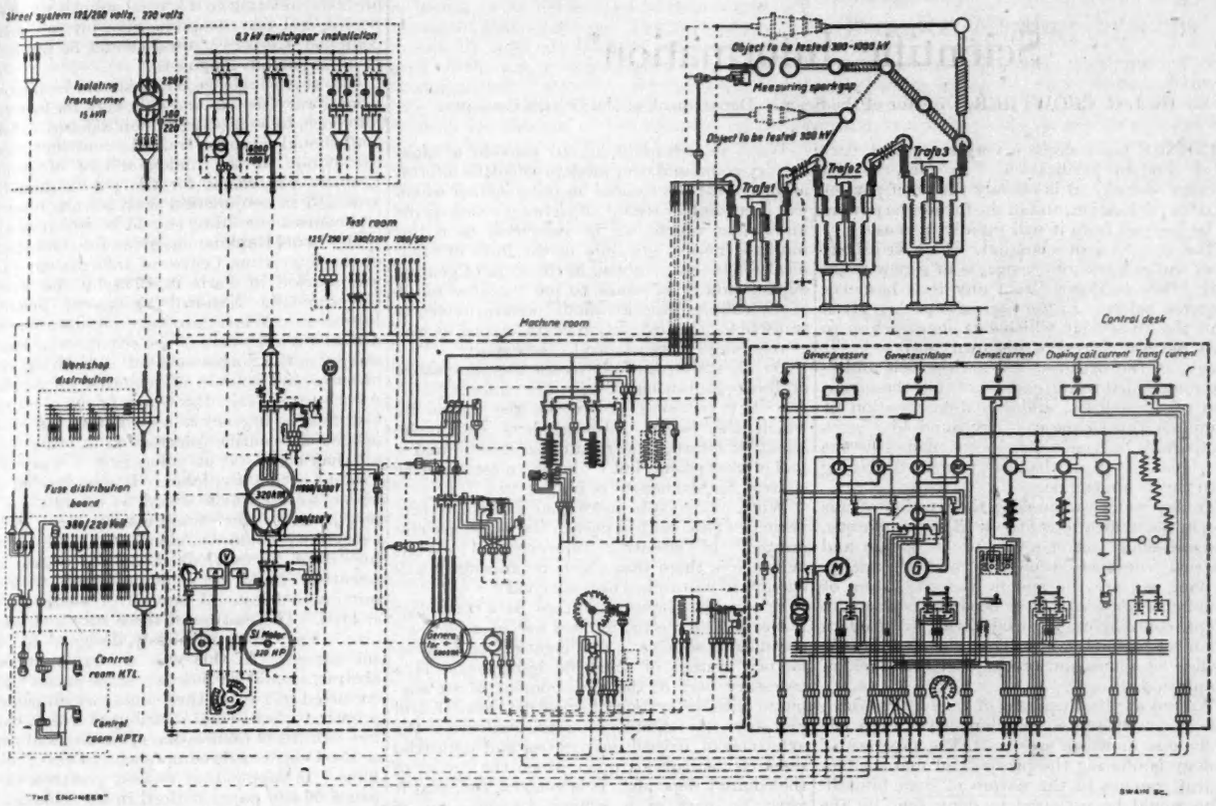


FIG. 5

A combined time-diverting relay is provided in the oscillograph, in the neighbourhood of the diverting plates, for rapid and slow single-logarithmic time diversion, as well as for single and repeated time diversion with linear scale.

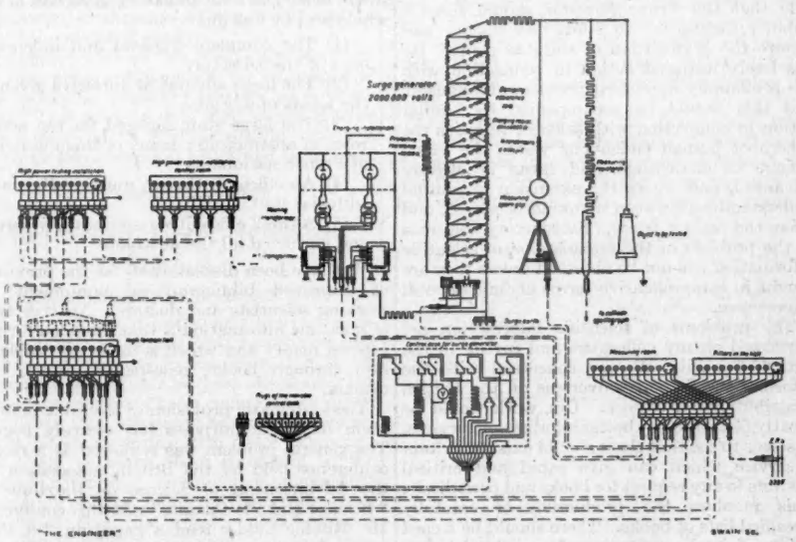


FIG. 6

The cathode ray oscillograph is mounted on a switch desk. It contains four rectifiers for feeding the collecting coils and the time relay and for shifting the zero lines. The measuring instruments, switches, and regulating resistances are let into the surfaces of the desk. In order to be able to dispense with the inflow and outflow of cooling water the oscillograph was provided with a molecular pump. The cathode ray oscillograph is not only to be used in the H.T. laboratory, but must also be capable of being installed anywhere in the works in the case of tests on large objects, and placed close to the latter; it was therefore made movable. For this purpose the oscillograph, together with the source of voltage (comprising a transformer for 200/50,000 volts, a rectifier valve, a heating transformer, a special condenser, and a damping resistance), was mounted on an iron frame serving as chassis, under which two motor-car axles can be inserted and secured.

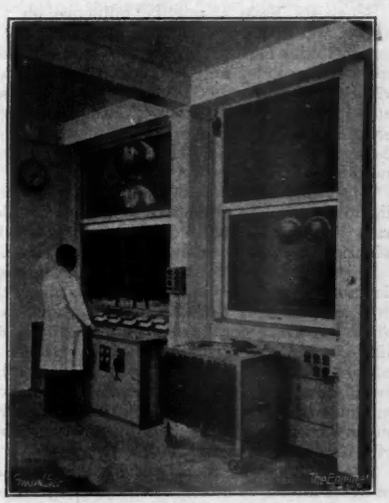


FIG. 7—*Measuring Room with Control Desk and Movable Switch Desk*

The laboratory is provided with recording and measuring instruments for checking the air pressure, the temperature, and the dampness of the air. The laboratory is furthermore equipped with portable mixing and spraying plant for tests under rain. The floor round the oil tank,

† See K. Berger, "A New Cathode Ray Oscillograph," *SEV Bulletin*, 1940, No. 5, page 113.

as well as its cover, are provided with water outlets on account of this.

With the erection of this installation the Oerlikon Company now possesses one of the most modern and best-equipped H.T. laboratories. The research work carried out through its medium has already led to very interesting results in the field of lightning arrester construction and will undoubtedly help to promote further advances in the whole H.T. field.

Scientific Information*

By J. G. CROWTHER, Director of the Science Department of the British Council

SCIENCE has become a very important part of modern civilisation. In fact, in the opinion of many, it is already the chief part of modern civilisation, and in the future the powers to be derived from it will rapidly increase.

The situation of mankind, which is arising from the progress of science, is of a new order and differs in degree from any that has ever occurred before. In the past, science has given man the knowledge which has enabled him to turn natural forces to his own purposes. It began, in the broadest way, with such understanding as led to the control of fire, the invention of agriculture, and the domestication of animals. During the past two hundred years a comparable advance has been made by the development of mechanical power, beginning with the steam engine.

To-day we are witnessing the fruition of this age, in the unification of the world by technique, and especially through the use of steam and internal combustion engines and electricity. In fact, we are the agents and spectators of social changes which have become necessary to adapt contemporary social forms to modern technical possibilities. The violence of the conflict is a measure of the degree of lack of adaptation.

We are at the threshold of a new age which will be vastly more disturbing than even the lively one in which we live. The progress of biology is offering the prospect of making biological changes in the nature of man himself. Who would be prepared to deny that by the year A.D. 2000 biochemists and cytologists will have made discoveries capable of being applied to the control of the biological nature of human beings? May it not be possible, through hormone discoveries, easily to effect the change of temperament of large numbers of human beings?

Who can foresee the end of such advances during the next few centuries?

Scientists have a mighty influence on the future, and therefore must bear their part of the responsibility for it. The old idea that scientists are a-responsible, and are permitted to view with indifference whether their discoveries are turned to good or evil is out of date. The forces being released are now of such dimensions that those who discover them cannot remain indifferent to their use.

The social situation demands that the prodigious instrument of modern science be handled with knowledge and judgment, not only by scientists, but by the community as a whole.

This, in my view, is why the efficient organisation and use of scientific information is one of the chief problems of the day. If mankind as a whole remains ignorant of science and its possibilities, and scientists themselves remain a minute body of ingenious but a-responsible social amateurs, what will come of the new and incomparably powerful cultural weapon—modern science? Will mankind destroy itself with its own inventions?

The decline in the reproduction rate of human beings is already a biological and social problem of major magnitude. Perhaps it is the most serious problem at present confronting humanity. I have little doubt that the problem will ultimately be solved, and methods of persuading human beings to keep their kind in existence will be found. But not, perhaps, before there have been extraordinary changes in the present balance of population in the world.

What is Britain doing to provide a satisfactory command over modern scientific information? Has she created an organisation which will immediately record all advances in scientific knowledge which can be consulted at a few minutes' notice, not only in the form of technical references, but also in the form of general explanation? It seems to me that the index of scientific information should contain abstracts suitable for the instruction of statesmen, as well as references of assistance to the expert.

Do our statesmen fully realise the importance of the organisation of scientific information? Are they prepared to provide the means by which the expert bibliographers can make scientific information readily accessible, and a tool of vast power, but under the most sensitive control, for the benefit of humanity?

What evidence is there that Britain is preparing to play her full part in the world use and mastery of scientific information? What evidence is there that she is organising it well enough to ensure her own survival?

Britain can have no future as a first-class Power unless she modernises her scientific and technical resources. The creation of a satisfactory system of scientific information is a necessary part of the development of an adequate national system of scientific research and industry. It should be connected with the extension of British universities and industrial research institutions upon which the future of the country depends. It is evident, too, that it must be part of a general organisation of scientific information for the whole British Commonwealth.

There are so many problems of first-class importance in connection with the organisation of science and the development of scientific research and scientific industry, both from the national, the Commonwealth, and the international point of view, that it seems very desirable that the Prime Minister should form a Cabinet Committee to study the matter and inspire the preparation of suitable plans. He has lately initiated action in connection with the profoundly important problem of language, and this should be accompanied by similar action in connection with science, which is the sphere of human endeavour where the interchange of knowledge and ideas is already advanced, and where the extension of mutual understanding between mankind is easiest, and offers the earliest fruits. Satisfactory solutions of the problem of the organisation of scientific information will not be obtained unless they are sought in comprehensive terms of fundamental importance.

The problems of scientific information are impressed on my colleagues and myself in the British Council. We are concerned with the information of peoples overseas on the British contributions of science. Our work would be greatly facilitated by better information services. It seems to me that there should exist in Britain a service which can give rapid and critical answers to any request for books and periodicals. This involves the production of carefully classified lists of books. There should be a card index of books so cross-referenced that any normal inquiry can be answered within a few minutes. Classification should be by degree of difficulty, style, and critical appraisement, as well as by title and subject. I would like to see a great index which contained reviews of books, in addition to bibliographical details. The reviews, say, perhaps 250 words long and printed on the back of the card, should be by the leading scientists in the nation. The index would be a repository of instructed opinion and a vast scientific literary work of style and distinction. I imagine the country's scientists would be proud to co-operate in such an activity.

The centralisation of abstracting services is desirable. Instead of separate scientific institutions in each country trying to abstract the world literature in any particular sphere, all abstracts relating to a special subject should be pooled and one comprehensive internationally compiled abstract journal should be published in all important languages.

Out-of-date science books should be removed from library shelves and only kept for historical reference, to be produced upon request. Library staff should comprise trained scientists to assist the public in the understanding of science. Lectures on science for the public should be arranged in conjunction with science libraries, and courses of reading should be recommended.

Mr. Louis Rapkine has given me some details of the interesting Centre of Information which was started in Paris in 1939 by the French Government's National Centre of Scientific Research. When general mobilisation was declared a large part of the scientists of France serving in the Forces were cut off from the usual libraries and sources of scientific information. At the same time, the Government more than ever felt the urgency of assimilating the world's output of scientific information in order to use all that could be of value in the war effort. Prompt action was taken. It was decided that two qualities which would be essential in the new institute were comprehensiveness, so that everything could be glanced at and nothing important be overlooked, and speed, so that scientists could be kept informed with the minimum delay. A service of abstracts was started. The feature of these was their shortness. They were ruthlessly designed to serve the expert. In this way a large number of abstracts could be put in a small space. They consisted of two or three lines, which could be prepared quickly and distributed within one or two months of publication of the original paper.

The Centre made comprehensive use of microfilms. It supplied on request positives of the pages of any paper noticed in its *Bulletin*, and it also acted as a library of original manuscripts, so that microfilms of these could be provided even before they had been published in any journal, thus saving printer's and editor's delays. The cheapness and effectiveness of such microfilm services are now widely known and appreciated.

The total cost of the Centre was remarkably small, being less than £6000. The success of the whole project was due to :—

(1) The complete freedom and independence of the Director.

(2) The large amount of initiative given to the heads of sections.

(3) The large staff engaged for the actual work of abstracting; many of them were not of French nationality.

(4) An efficient, though numerically small, editorial staff.

(5) A small efficient revision staff, who read and corrected all the abstracts.

We have been discussing so far the provision of improved bibliographical equipment for working scientists and doctors. Another type of scientific information is that intended for the general reader and which is made accessible to him through books, newspapers, radio, and cinema.

The systematic provision of scientific information for these purposes has scarcely begun. The general problem was reviewed at a recent conference held by the British Association for the Advancement of Science on the topic of "Science and the Citizen." At this conference Mr. Ritchie Calder read a paper on "A Plan for an Institute of Scientific Information." He recalled the discussions held just before the outbreak of the war and encouraged by the International Institute of Intellectual Co-operation and the Rockefeller Foundation, on methods of pooling scientific knowledge and making it more accessible.

Mr. Calder envisages a British Institute of Information, which will supply journalists and others with scientific information which will be instructive without being dull, and accurate without being pedantic, and will convert the

* From an address delivered at a conference on September 17th and 18th arranged by the Association of Special Libraries and Information Bureaux, at Burlington House.

wide public interest in science into a genuine social instrument, which will help mankind to utilise science to its own maximum benefit. This Institute would work in close connection with similar institutes in other countries, so that an international pool of scientific information would be established.

This would be prepared in a form which could be given to the news agencies and newspapers and to the radio and film organisations. These organisations would be able to telephone to the Institute at any time and be able to secure a reasonably accurate account of any scientific discovery or development at an hour or two's notice.

The Institute would have a panel of expert advisers in all branches of science, and a staff which could produce material which could be converted by scientific journalists into news and leading articles, broadcasts, cinema news reels, &c.

At the same conference Dr. Arnold Raestad, of Norway, gave an account of the work of the International Institute of Intellectual Co-operation and the Rockefeller Foundation. The Committee of the International Institute, which included Dr. Julian Huxley and Monsieur Henri Laugier, recommended the creation of an international centre for scientific information, which should have two main objectives. The first would be a continuous recording of the progress of science, and the second the mobilisation, as need and demand arise, of information on any scientific point of current interest. It would organise co-operation between the original scientific specialist, the intermediary scientific exponent, and finally the journalist or populariser.

The Committee worked out a draft organisation in detail and was of opinion that its work should be carried out through the linking and extension of existing organisations.

Dr. Raestad is of the opinion that in reorganising the world the United Nations have no more fundamental task and no more urgent one than to implement a proper international co-operation in the adequate presentation of the results and methods of science to the peoples of all countries.

That seems to be very true. Arrangements for a proper international bibliographical and scientific information service should be incorporated in all general world treaties and world committees of nations for the preservation of peace. The most urgent task of bibliographers and scientific informationists would seem to be to get their proposals on to the agenda for the forthcoming settlements of the world and to have their proposals ready.

In order to achieve this, they must work out their own plans and persuade the statesmen of their respective countries to take appropriate action. It is evident that they should discuss these matters at the earliest possible moment with those Ministers most concerned with them.

The Brush Craft Selection School

(Communicated by the Brush E.E. Co.)

The importance of craftsmanship to the engineering industry has long been recognised, and the trade apprenticeship courses at the Brush Electrical Engineering Company are among the most comprehensive in the country. As far as practicable, the company has always endeavoured to select youths with those characteristics likely to make them successful in the engineering industry. In the course of operating the existing scheme, however, those responsible have found that the problem of selection is much more difficult and more complex than might at first be realised. There is still room for improvement in connection with the intake of youths to the engineering industry in regard to the following points :—

(*a*) Despite careful selection from the schools, with the full co-operation of the teaching staff, a number of boys are still taken who will never make engineers.

(*b*) Even when well suited for engineering, the variety of jobs which may be chosen is considerable, and although most boys have an aptitude for a specific craft, this is frequently not brought to light early enough in the training and in many cases not at all.

It is often said that manual dexterity is the essential characteristic for engineering craftsmen. This, however, is by no means the whole of the story, as manual dexterity in itself may be much more evident on certain types of movement than on others. Two boys may be of an equally high standard of intelligence and have all the major characteristics required for an engineering craftsman. One of them, however, may not have that keenness of eyesight required for the use of micrometers, calipers, and the observation of cutting tool performance which is necessary for a first-class machine tool operator. He may, on the other hand, have highly developed finger and thumb muscles and bones which make him specially suitable for armature winding. The other boy may have underdeveloped hands, but all the characteristics we wish to have in our ideal machine tool operator. The existing methods in most works of placing these boys are somewhat dependent on the demands for expansion of labour in a particular trade, and even in those works where the apprentice training is well controlled the approach is usually one of giving a boy a second chance if he fails at the craft first started upon.

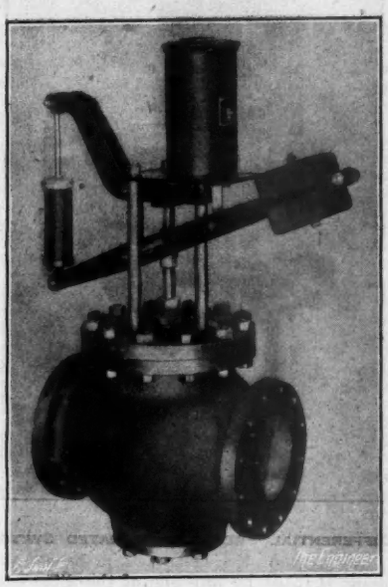
In an endeavour to grapple with this problem the Brush Company has instituted a craft selection school. All boys, before being indentured as trade apprentices, serve six months in this school and every youth does from four to six weeks on each of the following trades :—Machining, fitting and assembly, armature winding, carpentry, welding, and tinsmithing. Record books are written up by the boys of their work week by week and the instructors record the progress made. This craft selection school, although only opened this year, is already showing that certain boys have distinct aptitudes for particular crafts and, although even good at others, are clearly marked out for success in one particular trade. It is also evident that we shall be able to put our hands on the misfits and divert them to some field other than engineering before they have become too old to make the change.

The school works a shortened week of forty-four hours. The boys "clock on" as in the factory and strict discipline is enforced, with no smoking. The work done in the school is actual production of simple parts, such as keys, dowel pins, and tool-boxes, for live contracts in the factory, as we believe the psychological effect of making something useful is important. The school is being operated on the principle of quality first. There is, of course, no piecework and everything is done to encourage habits of tidiness, cleanliness, and accuracy in the boys.

When the scheme was first developed it was considered to be an experiment. Although it has only been in operation a short time, it is already evident that, viewed from the aspect that an experiment is a project, the results from which are uncertain, the craft selection school is no longer experimental, but a marked step forward.

Emergency Valves for High-Pressure Heating Systems

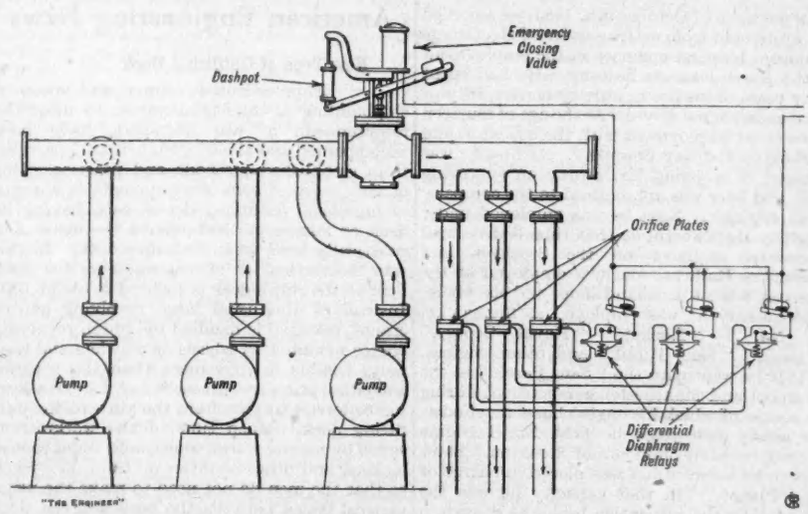
The forced circulation high-pressure hot water heating system has many advantages over the more usual steam or ordinary hot water system, but its use calls for greater safeguards, because of the relatively large amount of stored energy in the system which, in case of a burst pipe, would result in the production of enormous



EMERGENCY VALVE FOR HEATING SYSTEM

quantities of steam, as the water would immediately flash into steam when released.

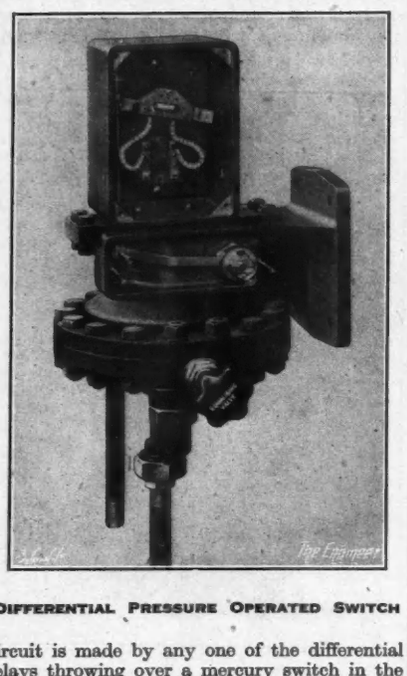
To provide a safeguard in the event of the fracture of a pipe due to an air raid or any other accident, Hopkinsons, Ltd., of Huddersfield, have developed an automatic shut-off valve, illustrated herewith, operated by an increase of flow above normal. In the first place, it was thought that a valve operated by pressure drop would fill the requirements, but on consideration it was realised that, as the water instantly flashed into steam when released, there might not be sufficient pressure drop in the system to operate a valve until serious damage had been done. There was also the possibility of the plant being run at a lower pressure, resulting in the valves



ARRANGEMENT OF EMERGENCY VALVE AND OPERATING SWITCHES

closing from this cause. It was therefore decided that the valve would be more satisfactory if controlled by flow, and the valve illustrated has been designed to operate on this principle.

The valve itself is a modified form of the makers' electrically released quick stop valve. The modification consists of the provision of a long dashpot to control the speed of closing in order to prevent shock which might cause a more serious situation than that which the valve is devised to prevent. The valve is latched up in the open position, being set by hand and closed by releasing this latch electrically. The



DIFFERENTIAL PRESSURE OPERATED SWITCH

circuit is made by any one of the differential relays throwing over a mercury switch in the case of a small increase in differential pressure across the metering disc produced by an increase in flow, such as would result from excessive leakage caused by a burst or blown gasket. When released the valve closes by gravity. Another advantage of using an orifice plate as a means of providing the operating impulse in preference to a simple pressure connection is that it can be fixed conveniently near the boiler, whereas the pressure connection is better the nearer it is fixed to the break—a position impossible to anticipate.

Sixty Years Ago

A Venerable Railway Engineer

In our issue of October 5th, 1883, we recorded the retirement from active service of Mr. George Jennison, foreman engineer in the employment of the North-Eastern Railway. He had spent sixty years of his life in railway service, fifty of them as an engine driver. At the age of fourteen he received employment with the Stockton and Darlington Railway Company. At first he was engaged in assisting Mr. Storey on surveying work and later was apprenticed to the company as an engineer. Next he was employed under Timothy Hackworth, at that time a divisional locomotive engineer on the Stockton and Darlington Railway, and was employed at the company's West Auckland shops and elsewhere. Subsequently he was employed as fireman on the No. 1 "Rocket," "Royal George," "Planet," "Sans Pareil," and other engines. In 1829 he went with the "Sans Pareil" to the Liverpool and Manchester competition, during the course of which his engine burst a cylinder. For nearly two years he fired No. 1 engine running between Shildon and Stockton. Later he became a driver and was placed in charge of the "Planet." In that capacity he was the first to cross the suspension bridge at Stockton. He also drove the first engine to run between York and Darlington. He ran the experimental trial of the "Big A" engine between these two towns against the Great Western Company's engine and went with the three-cylinder engine to London to run against Crampton's patented locomotive.

Shipbuilding in England and America

In a broadcast message from London to America, on Thursday night, September 23rd, Rear-Admiral H. L. Vickery, U.S.N., Vice-Chairman of the United States Maritime Commission, made reference to his inspection of shipbuilding yards and marine engine works in England, Scotland, and Northern Ireland. He made reference to the differences of building and manufacturing ships, and spoke of the old and sometimes cramped shipyards in which British shipbuilders were successfully building ships. To-day, he said, he had seen warships and cargo vessels similar to "Liberty" ships coming out of these small yards. Long shifts and Sunday work were standard practice and black-out conditions enforced one-shift working. Man-power shortage in British shipyards was acute, and women and young boys were trying to stem the tide caused by the shortage of shipyard labour. As in America, there were some differences in opinion between shipbuilders and employees and sometimes between shipbuilders and Government maritime officials, and the problem of absenteeism was a common one. Admiral Vickery then went on to say that his inspection had shown that British shipbuilders build their ships at less cost than American shipbuilders. The actual man-hours taken to build a cargo vessel in this country are far under those taken in America for the construction of a similar ship. This, Admiral Vickery said, was something to conjecture with when the war was over and the sea lanes of the world were again open to commerce. That a given number of men should take less time to turn out a comparable ship was both a record and a challenge. In Great Britain this had to be done with less space, with severely rationed workers, fewer tools, and fewer facilities, and the ever-present darkness of black-outs. There was, Admiral Vickery continued, another side to the picture. If America had not got into mass-production strides on its shipbuilding, regardless of man-hours, then the war picture might to-day have had a very different pattern. It was recognised in Britain, Admiral Vickery said, that American shipping, as much as any one American effort, had helped to save this island from invasion. Wherever he had gone, Admiral Vickery concluded, he found nothing but co-operation and agreement. The hope was freely expressed that our two nations would continue to work together in peace as we now are working in war.

American Engineering News

New Type of Outfitting Dock

Unprecedented volume and speed in shipbuilding at American yards, to meet the requirements of war transport, have been accompanied and aided by numerous departures from established methods and practice. One of the latest of such developments is a series of high-level outfitting docks, each having its deck or floor some 30ft. above the water and practically level with the ship's deck. In this way the vertical lift of material from the dock floor to the ship's deck is reduced to about 10ft. Instead of the usual large revolving gantry cranes, material is handled by 20-ton revolving cranes mounted on wheels or crawlers and thus more flexible in movement than the gantries travelling on rails. An incline of 1 in 20 allows motor lorries to pass from the yard to the outfitting deck. Much time of the workmen is saved by having stores, tool rooms, toilet rooms, lockers, and other facilities on the upper level, so that the men do not need to make the usual vertical travel between the yard and the ship. The dock or pier is 73ft. wide and 620ft. long, built of creosoted piles and timber, with a plank floor, 4in. thick, supported by 8in. by 16in. joists laid upon transverse caps or beams. A framing about 5ft. above the water carries a walkway giving access to a side port in the ship's hull, opposite the engine-room. At the outer end of the pier is a 50-ton derrick for handling material delivered on barges. Among other departures from established shipyard practice, as noted above, may be mentioned the following:—(1) Increased use of sidewise launching; (2) building and outfitting ships in dry docks or basins, thus dispensing with inclined ways and launching; (3) replacing riveting by welding to a very wide extent and introducing numerous devices to facilitate the welding operations; (4) an astonishing expansion of the manufacture or prefabrication of large units, such as bows, sterns, deckhouses, bulkheads, &c., at yard shops or outside shops. These units, moved by tractors, are swung into place by cranes to be welded or riveted to the hull.

American Steel Research

Research in both the composition of steels of various grades and the practical operations of steel manufacture has been stimulated in the United States by the enormous demand for and consumption of steel for various purposes relating to war conditions. This fact has been evidenced in recent papers before the American Institute of Mining and Metallurgical Engineers. One important paper, dealing with the development of research and quality control in modern steel works, points out that the manager of such a steel plant must make a scientific and technical approach to the problem of quality or special composition of steels and must consider also the factors of quantity control and production cost. Raw materials, shop arrangement and mechanised equipment, and shop practice all enter into the problem. The importance of quality control became prominent with the development of companies specialising in the production of steels of certain character or composition. Factors in manufacture then include accuracy and perfection in gauge, surface finish, physical and chemical constitution, definite grain size, and good internal structure. Thus research and operating metallurgists and practical "steel men" work together in developing new grades of steel based on abstract metallurgical theories. Along the same line of thought is a paper on the problems of "total operation" in steel manufacture, this term implying the inter-relation of the blast-furnace and the open-hearth furnace. Many problems, such as delays in furnace charging and in the mechanical handling of materials, are related intimately to the metallurgical problems, and the two classes of problems must be considered together. For instance, there is the phosphorus cycle in a steel plant using open-hearth slag in the blast-furnace. Phosphorus build-up in the iron is not continuous, but levels off at a constant value. Furthermore, average daily production depends on the number of open-hearth furnaces in operation, the weight of hot metal delivered to them, the percentage of hot metal in the charge, and the quality of the scrap.

British Manufacturers of Petroleum Equipment.—The Council of British Manufacturers of Petroleum Equipment was formed with three main objectives: first, to seek active collaboration with Government Departments, having in view the representation of the interests of the petroleum industry in the United Kingdom and Northern Ireland; secondly, to promote greater attention by British engineering firms to the requirements of the oil companies for equipment at home and abroad; and thirdly, to acquire and disseminate among the firms interested up-to-date information regarding such equipment, and in all these ways to help the national effort in combating unemployment in the post-war period. The first annual general meeting was held on July 27th last, when the new Executive Committee of twelve members was elected. The following are the officers of the Council:—S. T. Robson (representing Head, Wrightson and Co., Ltd.), Chairman; N. Matheson (representing Le Grand, Sutcliff and Gell, Ltd.), Vice-Chairman; C. R. Sams (representing George Kent, Ltd.), Hon. Treasurer; T. L. Bonstow, Hon. Secretary. The address of the Hon. Secretary is at 47, Parliament Street, Westminster, London, S.W.1.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer.

Iron and Steel in the United States

The efforts to increase the production of iron and steel in the United States have been successful, and the revised estimate by the American Iron and Steel Institute puts the blast-furnace capacity of the country at July 1st at 64,500,000 tons of 2000 lb. per annum, including ferro-manganese and spiegeleisen; this is a gain of 553,000 tons from January 1st, 1943, and an increase in the annual capacity since 1940 of 9,000,000 tons. At the works of the Carnegie Illinois Corporation at Pittsburgh, the whole of the twenty-four blast-furnaces are in operation after relining, whilst at Youngstown twenty-four out of twenty-six are working, two being laid idle for relining and repairs. In the Chicago district one steel company is operating six blast-furnaces, five of which have been in continuous operation for three years, producing 1000 tons of pig iron daily. In Mexico a new blast-furnace of 500 tons daily capacity has been put into operation at Monterey. The steel capacity of the United States, revised to July 1st, is estimated at 90,880,860 tons yearly. This represents an increase of 10,000,000 tons in three years. It includes open-hearth steel, Bessemer steel, and electric furnace steel. A total steel capacity of 96,000,000 tons on July 1st had been the target, but new construction by the War Board, principally for synthetic rubber and high-octane petrol, was given priority. It is expected that the 96,000,000 tons capacity will be reached early in 1944. The steel production at the end of August stood at 99·4 per cent. of the capacity, and was equivalent to a weekly output of 1,732,500 tons. At Pittsburgh operations at the steel works were at 100 to 101 per cent. of capacity, at Youngstown 90 per cent., and at Chicago 99·4 per cent. The capacity of the United Steel Corporation at the half-year was estimated at 31,330,700 tons, or about 34 per cent. of the total industry. The domestic demand in the United States is accounting for a very large tonnage of steel, and recent new business has included contracts from a group of three railways for 1525 steel wagons.

The Pig Iron Market

The situation in the pig iron branch of the iron and steel markets is more satisfactory probably than at any time since the war began. The producing works are assured of full operation during the fourth quarter and there seems no likelihood that any disturbing factor in the production programme is likely to develop. The raw materials position is comfortable. The quantities of coke available amount to a glut in the market, whilst liberal supplies of native ironstone are available. The imports of high-grade ores from North Africa have improved the position in the hematite and low and medium-phosphoric pig iron departments. There is a steady demand for high-phosphoric pig iron, and although among normal users the light castings foundries are not by any means fully employed, requirements appear to have increased during the last month or two, whilst other industries engaged upon war work are using larger quantities of this pig iron as a substitute for descriptions that are in shorter supply. The engineering and jobbing foundries are kept busy on Government work, and lately have received more liberal supplies of hematite and low-phosphoric pig iron. The demand for refined iron has been in excess of the supply for some time, but of late larger tonnages of this quality have been made available for consumers engaged upon special castings. In the hematite department the position is not entirely satisfactory, in spite of larger releases. The expansion in output as a result of the imports of North African ore have had an appreciable effect in easing the position, but larger supplies of ore would be welcomed. The engineering foundries have benefited considerably from the increased deliveries, but the Iron and Steel Control still finds it necessary to keep a tight hand upon the distribution of hematite, and there is still a strong request for medium and low-phosphoric pig irons for use as substitutes. The production of basic pig iron is upon a large scale, but although it is sufficient to keep the steel industry fully supplied there seems to be little margin.

The Midlands and South Wales

The conclusion of delivery period III finds the Midland iron and steel industry fully employed. Practically the whole output is required by consumers employed upon war work. The tonnage of uncompleted contracts at the end of the period is not expected to be considerable, since the Iron and Steel Control has now great experience in the production capacity of the various works. In the past week or two there has been a rush by consumers to cover their allocations, and the producing works will be hard pressed until the end of the year in meeting their obligations. The demand has changed little over the past few months, and the emphasis is still upon plates. It is not expected that the requirements of the shipyards will diminish to any extent during the war, but recently there has been a fresh revival in the demand for alloy steel, principally from the aircraft manufacturers, and business in this description is likely further to expand. All the works producing alloy steel are pressed to the limit to increase production which stands at a high level. The re-rolling works in the Midlands are actively employed, and their requirements of semi-finished steel are on a considerable scale. Lately, however, the increased production of English and Welsh works has eased the position, and consumers of billets and sheet bars are now in a happier position than for some time. There is a heavy production of small steel bars and shipbuilders and others are taking up large quantities of small sections. Structural steel is in good demand, excepting in the heavier categories, business in which shows a declining tendency. On the other hand, there is a continuous and strong request for light joists and sections. The sheet mills are as busy as they have been at any time since the war. The demand, which slackened off for a few weeks, has now strengthened, and the amount of business coming forward is sufficient to take the place of the contracts worked off. Large quantities of thin sheets also are required by Government Departments, and sheets of special finish are being taken up in good tonnages. The iron and steel works in South Wales are fully employed, a large proportion of their output being for priority purposes. The production of semi-finished steel has been increased lately, but the whole output passes rapidly into consumption. The tinplate market, however, remains quiet, largely as a result of the regulations restricting the use and manufacture of tinplate.

Scotland and the North

The Scottish iron and steel industry is working at unabated pressure to meet the heavy demand from the war industries. There has been no relaxation in the pressure to obtain delivery of plates. Recently, however, if anything, the demand has strengthened somewhat, as the shipyards are endeavouring to accumulate reserve stocks, and in this they are acting upon official advice. For a long time the resources of the plate mills have been taxed to meet the insistent request, and that they have been successful in maintaining a steady stream of supplies to the ship-repairing yards and other big consumers, such as the marine engineers and locomotive builders, is an indication of the ability of the industry to meet and overcome difficulties. Lately some of the locomotive builders have been engaged upon important contracts for Russia, as well as upon repair work. The steel works producing structural steel are fully engaged beyond the end of the year, and there has been no slackening in the demand for small sections, considerable tonnages of which are required by the shipyards and in the manufacture of Army mechanical vehicles. The volume of business passing in large sections, however, is not on a large scale, and there is no indication of the call for this class of steel material improving. Steel bars, both large and small are in active demand, and there is a tendency for the delivery dates for the larger diameter bars to lengthen. The engineering industry continues to press for the delivery of considerable quantities, and there is also a steady request for ferro-concrete bars. An active business is passing in small steel bars, and the re-rolling works are turning out considerable quantities and are likely to be engaged on this work for a long time. Their position, however, so far as raw materials are concerned, is satisfactory, and they are obtaining fully supplies of semis. Active conditions rule in the Lancashire steel market, although the amount of business passing in heavy joists and other heavy descriptions of structural steel is rather quiet. There has been no slackening, however, in the call for the lighter sizes, and the re-rolling works and the steel works producing this material are engaged for some time ahead. The plate position has not altered, and the producers have to meet an insistent demand, which, if anything, shows a tendency to strengthen. Important tonnages of small black and bright drawn bars are passing into consumption, and there is a considerable volume of inquiry circulating in the market. The works, however, are so well booked that they show some reluctance to add to their commitments. Forge masters are taking up good supplies of blooms and billets. Activity at the steel works on the North-West Coast is fully maintained.

The North-East Coast and Yorkshire

A big output of iron and steel is being obtained by the works on the North-East Coast. Practically all the finishing departments are working at capacity, and are likely to continue to do so for an indefinite period. A satisfactory feature of the situation is that the raw materials position is satisfactory, and there is no lack of blast-furnace coke or limestone, whilst recently the supply of billets and sheet bars for the re-rolling industry has materially improved. This has been achieved by a larger output from home works, and has resulted in fewer withdrawals from the stocks of imported material, and has relieved the Control from the necessity of maintaining big imports of semis from abroad. The re-rolling industry, nevertheless, has to continue to use fair quantities of "seconds" material, including shell discard, crops, &c. The demand upon the re-rolling works absorbs the whole capacity of this branch of the industry, and they have to meet the continuous demand for small sections and small steel bars and strip. Practically the whole of the re-rolling works have contracts in hand sufficient to keep them fully employed until the end of the year. The demand for plates is fully maintained and large tonnages are passing to the shipbuilding industry. A considerable volume of new business in sheets has come to hand recently, but the manufacturers are reluctant to add to their commitments since most of them are booked up with Government orders until the early part of next year. At the moment, however, the tonnage of new business coming forward is probably in excess of that which has been completed. The steel bar mills are actively engaged, and there is a tendency for delivery dates to lengthen. The demand for all descriptions of iron and steel which has been experienced since the beginning of the war by the Yorkshire steel works is fully maintained. There is a heavy demand for basic steel, which is well spread over the market. The producers of acid carbon steel also are carrying heavy order books, and the whole productive capacity of this branch of the industry is fully employed. Recently there has been a revival in the volume of business in stainless steel and in corrosion-resisting steel, whilst the demand for alloy steel from the aircraft makers and makers of military and mechanical vehicles is steadily increasing. In this department, however, there has been a noticeable decline in the amount of business in the more expensive descriptions of alloy steel.

Iron and Steel Scrap

Changes in the iron and steel scrap market are few and far between, but recently there has been some improvement in the demand for the lighter descriptions. There has been no lessening in the request for the heavier and better qualities, but the scarcity of these has led to larger purchases of other qualities, the intention being to supplement the supplies of the description which are not easy to obtain. The official prices have not been changed, and so far as can be seen there is no likelihood of their being altered. Good heavy mild steel scrap cut to furnace and foundry sizes is eagerly sought by consumers. The steel makers, on the whole, are well provided with this heavy quality scrap, but the consumption is at a high rate, and most buyers are prepared to take as much of the material as they can find. Good quantities of bundled steel scrap and hydraulically compressed steel shearings are being taken up by acid steel makers, whilst there is a more active demand than for some time past for mild steel turnings. Steady quantities have recently passed into consumption of the good heavy sort, as well as chipped grades. The demand for mixed wrought iron and steel scrap for basic steel furnaces has been slowly improving for a week or two, and has now become fairly strong. Supplies of good heavy are on the short side, and as the demand improves consumers are showing more eagerness to obtain parcels. Larger quantities of light material also are being taken although the position has not greatly changed. The improved demand has also extended to compressed basic bundles, although this arises from the difficulty in obtaining all the heavy material required. Little change has taken place in the cast iron scrap position. Buyers of heavy cast iron in large pieces and furnace sizes are taking all the parcels that become available. Light cast iron is also in rather good demand, whilst machinery cast scrap in cupola sizes is finding a ready market. The disposal of light and bushy steel turnings presents some difficulty, as buyers are only slightly interested in this description. On the other hand, cast iron borings are being quickly taken up by the blast-furnaces.

Notes and Memoranda

Rail and Road

SYNTHETIC RUBBER PRODUCTION IN TEXAS.—The production of synthetic rubber seems destined to become a great Texan industry. Plants, financed by the U.S. Government, for the production of a quarter of a million tons annually are now operating in part. The anticipated tonnage will be the total output of four plants, all of them polymerisation units in which butadiene and styrene produced from Texas petroleum and natural gas will be combined to make butadiene type synthetic rubber.

SWEDEN AND SYNTHETIC RUBBER.—To further the production of artificial rubber from calcium carbide, according to the formula discovered by Professor The Svedberg, Nobel prizewinner, and head of the Physical-Chemical Institute of Upsala College, the Swedish rubber industry and the Co-operative Union of Sweden have formed a company to provide Professor Svedberg with better facilities for his experiments. Sites for a factory and laboratory will be purchased near Upsala.

L.M.S. SPEEDS UP COAL SUPPLIES.—Four hundred L.M.S. coal trains a week are now run direct from the collieries composed entirely of wagons for one area only, instead of being made up of wagons for various destinations as was the case before the war. This arrangement clears the collieries more quickly, gives faster transport to destination, saves engine power by obviating the shunting of wagons through intermediate marshalling yards, and thus enables the 25,000 wagons involved to be used more often.

CAMEL-FOOT TYRES.—At the opening of the campaigns in the Western Desert a good deal appeared in the Press about the special-tread tyre supplied to the Eighth Army. This tyre was designed on the foot action of the camel. The models were tested on practically every type of sand that the desert had to offer, and it was found that the "camel-foot" tyres allowed the vehicle to stop and restart, whereas with the ordinary tyre a start could not be made without pushing. An unexpected tribute came from Rommel's men, who showed their preference for this tyre, by using captured British vehicles whenever possible instead of their own.

OMNIBUS SERVICE IN GREAT BRITAIN.—In May of last year there was founded the British Omnibus Companies Public Relations Committee, and its objects were recorded as being "to bring to the attention of the public and keep before them the value to the community of the services rendered by the omnibus companies affiliated to the Committee and the efficiency and economy of such services, to maintain a friendly understanding between the travelling public and the companies, and by publicity and otherwise to do all such things as may be considered conducive to the attainment of these objects." Its report for the period ended June 30th, 1943, discloses information about more than sixty concerns owning more than 13,000 buses. Two work more than 1000, the biggest fleet being that owned by the Birmingham and Midland Motor Omnibus Company, Limited. Another company in the North owns 987. Then there is a drop to the 400–600 group, seven in all, with the Southdown Motor Services fourth in the list, with 534 vehicles for passenger transport.

Air and Water

A ROLLS-ROYCE "BATTLE OF BRITAIN" EXHIBITION.—On Friday last, September 24th, we were invited to attend the opening ceremony at a "Battle of Britain" Exhibition, which has been arranged in the showrooms of the London office of Rolls-Royce, Ltd., 14, Conduit Street, W.1. It has been planned in close co-operation with the Air Ministry and the Ministry of Aircraft Production, and it was opened by Group Captain W. Helmore, C.B.E. He paid a warm tribute to the directors of Rolls-Royce, especially to Mr. A. F. Sidgreaves and Mr. E. W. Hives, their research and technical staffs, and the many thousands of workmen and women who had helped to maintain the growing output of "Merlin" engines. The Royal Air Force and the Fleet Air Arm appreciated their work to the full. It was a remarkable technical achievement, he said, to have avoided any break in production, and keeping the same bore, stroke, and speed, to have nearly doubled the output of the "Merlin." The engines shown include the "Eagle 8," installed in the Vickers-Vimy bomber, which later gained an Atlantic record, and two examples of the "Merlin XX," described in our issue of February 27th, 1942. The "Merlin 61" (see THE ENGINEER for December 18th, 1942) is also shown, along with photographs of pattern shops, finishing, machine and assembly shops. Tables prepared by the Air Ministry give full details of the Battle of Britain and the number of enemy aircraft destroyed. We noted that between August 8th and October 31st, 1940, no less than 2375 German aircraft were destroyed during daylight. The largest number brought down in any one day was 185 on September 15th. The directors of Rolls-Royce, Ltd., cordially invite the public to visit the Exhibition, which will be open for a further three to four weeks.

Miscellanea

DEVELOPMENTS AT THE TATA COMPANY'S WORKS.—A new plant of the Tata Iron and Steel Company, of India, for the production of iron by the Perrin process, is now in partial operation. The new wheel tyre and axle plant is in full production. At the Jamshedpur works the manufacture of ferro-alloys and ferro-tungsten is planned, and a plant is to be built for the manufacture of high-speed tool steels.

IMPLEMENT MAKING IN CANADA.—The Canadian Government has found it necessary to facilitate increased manufacture and importation of farm implements to ease the farm labour shortage. The supply of farm equipment which will be made available is equal in tonnage to approximately 77 per cent. of the average of 1940 and 1941. This is about the same percentage as has been authorised in the United States. Farmers will not feel much benefit from the increased manufacturing and import quotas until the crop year 1944.

Personal and Business

DR. H. E. WIMPERIS has been elected President of the Whitworth Society.

MR. A. G. STEWART has been appointed a deputy chairman of Stewarts and Lloyds, Ltd.

MR. F. WILLIAMS has been appointed Chief Mechanical Engineer, Canadian National Railways.

SIR MAURICE DENNY, Bart., has accepted the invitation of the Council to become President of the Junior Institution of Engineers for 1943–44.

MR. H. B. ROBIN ROWELL has been elected chairman of R. and W. Hawthorn, Leslie and Co., Ltd., in succession to the late Mr. E. C. Straker.

THE London office of Burton, Griffiths and Co., Ltd., and B.S.A. Tools, Ltd., has removed from 22, Old Queen Street, S.W.1, to 10, Mayfair Place, W.1 (telephone, Grosvenor 1422–5).

THE MINISTER OF FUEL AND POWER announces that he has appointed Mr. Charles C. Reid, who is at present Regional Production Director in Scotland, to be Director of Coal Production at headquarters.

MR. H. BELLMAN has been appointed Chief Mechanical Engineer, India Store Department, Office of the High Commissioner for India, in London. He succeeds Mr. A. L. Haas, who has retired after twenty-three years' service in the position.

THE MINISTER OF FUEL AND POWER has appointed Mr. J. Innes, C.B., to a newly created post of Director of Opencast Coal. Mr. Innes has up to the present been employed as Director of Services at the Ministry, and in this capacity has dealt with the supply and distribution of solid fuel.

THE BRUSH ELECTRICAL ENGINEERING COMPANY, Ltd., and Metropolitan-Vickers Electrical Company, Ltd., announce that they have fused their interests in the battery electric vehicle industry. The Brush Company has acquired the goodwill and business of the vehicle department of Metropolitan-Vickers Electrical Company, Ltd. The Metropolitan-Vickers company will continue to manufacture the motors, controllers, and electrical equipment, but the vehicle will be sold as the "Brush" electric vehicle.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

Institute of Fuel

Thursday, Oct. 14th.—Connaught Rooms, Great Queen Street, Kingsway, W.C.2. Presidential Address, by Dr. E. M. Smith. 12.30 for 1 p.m.

Institute of Transport

Tuesday, Oct. 12th.—Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. Presidential Address, by Sir William Wood. 5 p.m.

Institute of Vitreous Enamellers

Saturday, Oct. 9th.—Waldorf Hotel, Aldwych, W.C.2. Annual general meeting. 11.30 a.m.

Institute of Welding

Wednesday, Oct. 13th.—Conway Hall, Red Lion Square, Holborn, W.C.1. "Some Aspects of Machine Design," E. Hassler. 5.30 p.m.

Institution of Automobile Engineers

Tuesday, Oct. 5th.—Royal Society of Arts, John Adam Street, Adelphi, W.C.2. Presidential Address by G. H. Lanchester. 6.15 p.m.

Sunday, Oct. 17th.—LONDON GRADUATES' SECTION: 12, Hobart Place, S.W.1. "Automobile Industry," P. C. Kidner. 2.45 p.m.

Institution of Civil Engineers

Saturday, Oct. 9th.—YORKSHIRE ASSOC.: Hotel Metropole, Leeds. Chairman's Address, by K. L. Forster. 2.30 p.m.

Institution of Electrical Engineers

Monday, Oct. 4th.—MERSEY AND N. WALES CENTRE: Liverpool Royal Institution, Colquitt Street, Liverpool. Chairman's Address, "Industrial Power Supply," T. E. Houghton. 5.30 p.m.

Thursday, Oct. 7th.—Savoy Place, Victoria Embankment, W.C.2. Presidential Address, Colonel Sir A. S. Angwin. 5.30 p.m.

Wednesday, Oct. 13th.—WIRELESS SECTION: Savoy Place, Victoria Embankment, W.C.2. Chairman's Address, by T. E. Goldup. 5.30 p.m.

Saturday, Oct. 16th.—S. MIDLAND CENTRE: Grand Hotel, Birmingham. Chairman's Address, by D. Kingsbury. 12.30 for 1 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, Oct. 12th.—39, Elmbank Crescent, Glasgow. Presidential Address, by A. M. Stephen. 6.30 p.m.

Institution of Mechanical Engineers

Saturday, Oct. 2nd.—YORKS BRANCH: Hotel Metropole, Leeds. Chairman's Address, by G. Varley. 2.30 p.m.

Monday, Oct. 4th.—N.E. BRANCH: Mining Institute, Neville Hall, Newcastle-upon-Tyne. "Powder Metallurgy," J. E. Newson. 6 p.m.

Thursday, Oct. 7th.—N.W. BRANCH: Engineers' Club, Albert Square, Manchester. "Practice and Experience in the Production of High-Speed Helical Gears, with Special Reference to the Elimination of Transmission Noises," S. A. Couling. 6.45 p.m.

Saturday, Oct. 9th.—YORKS GRADUATES' SECTION: Hotel Metropole, Leeds. "The Mining and Making of Ferodo," W. S. Blackie. 2.30 p.m.

Institution of Production Engineers

To-day, Oct. 1st.—COVENTRY SECTION: Technical College, Coventry. "Engineering and its Effect on Social Life," Dr. K. G. Fenelon. 6.45 p.m.

Saturday, Oct. 2nd.—YORKS GRADUATE SECTION: Hotel Metropole, Leeds. "The Production of Surface Finish," J. L. Hepworth. 2.30 p.m.

Monday, Oct. 4th.—SHEFFIELD SECTION: Royal Victoria Station Hotel, Sheffield. "High Speed in the War-time Production Shop," Dr. G. Schlesinger. 6.30 p.m.

Friday, Oct. 8th.—EASTERN COUNTIES SECTION: Ipswich Museum, Ipswich. "Local Hardening," E. Bramhill. 7 p.m. MANCHESTER SECTION: Mechanics' Institute, Crewe. "Production Control," R. Appleby. 7.15 p.m.

Saturday, Oct. 9th.—MANCHESTER SECTION: Liverpool University, Brownlow Hill, Liverpool. "Production Control," R. Appleby. 2.30 p.m. YORKS SECTION: Hotel Metropole, Leeds. "The Production Technique of Industrial Plastic Mouldings," T. H. Richardson. 2.30 p.m.

Monday, Oct. 11th.—COVENTRY GRADUATES' SECTION: Technical College, Coventry. "Any Questions?" 6.45 p.m.

Junior Institution of Engineers

To-day, Oct. 1st.—39, Victoria Street, S.W.1. Discussion on Post-War Problems. 6.30 p.m.

Saturday, Oct. 2nd.—N.W. SECTION: Manchester Geographical Society. St. Mary's Parsonage, Manchester. Informal meeting. 2.30 p.m.

Friday, Oct. 8th.—39, Victoria Street, Westminster, S.W.1. "Economy of Fuel and Power," W. A. Christianson. 6.30 p.m.

Keighley Association of Engineers

To-day, Oct. 1st.—Victoria Hotel, Keighley. "The Direct Hydraulic System," F. H. Towler. 7.30 p.m.

Liverpool Engineering Society

Wednesday, Oct. 6th.—Municipal Annexe, Liverpool. Presidential Address, "A Brief History of the Municipal Services of Liverpool," Major H. Pryce-Jones. 6 p.m.

Manchester Association of Engineers

To-day, Oct. 1st.—Engineers' Club, Albert Square, Manchester. Presidential Address, by J. P. Hallam. 6.30 p.m.

The Newcomen Society

Wednesday, Oct. 13th.—Chartered Institute of Patent Agents, Staple Inn Buildings, Holborn, W.C.2. "Norris Locomotives in England and Europe," P. C. Dewhurst. 2.30 p.m.

Practical Planning Exhibition

Wednesday to Saturday, Oct. 6th to 30th.—Institution of Civil Engineers, Great George Street, S.W.1. 10 a.m. to 6 p.m. (except Sundays).

Royal Institute of Chemistry

Saturday, Oct. 9th.—S. YORKS SECTION: Department of Applied Science, St. George's Square, Sheffield, 1. Joint meeting. "Microchemical Analysis." 2.30 p.m.